Publication 296

1986
Field Crop Recommendations

Ministry of
Agriculture
and Food
ONTARIO

[illegible]
[illegible]

CEREALS

BEANS AND PEAS

CANOLA RAPESEED

SOILS

DES

-03955/

POLICY STATEMENT

Pesticide products listed in this publication have been reviewed by the Ontario Pesticide Advisory Committee and have been classified under the Ontario Pesticide Act.

Space limitations in this publication restrict the amount of detail which can be included in each recommendation. Detailed recommendations are provided, by law, on the container label of commercial products. Read and follow the directions, conditions, and limitations described on such labels. This is the only way to make effective, safe use of such products. See also General Information on Pesticide Usage section.

Additional information can be obtained from the local office of the Ontario Ministry of Agriculture and Food. See General Information section.

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seizure of the crop. Pesticides not listed alphabetically are in order of preference, with efficacy, toxicity and amounts of field experience all considered in the listing. It must be emphasized that in some cases, the most effective pesticides are highly toxic. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first.

**TEMPORARY REGISTRATION OF PESTICIDES

Temporary registration of a pesticide is a procedure which is frequently used prior to full registration. Temporary registration is only granted for a period of one calendar year. On December 31 of each year, the temporary registration status ceases. After that time period the pesticide may be discontinued, have the temporary registration extended or be granted full registration.

As of the printing date of this publication, the pesticides indicated with a (**) were registered on a temporary basis for use in 1985. The fate of these materials has not been fully determined for 1986. Growers are urged to check the registration status of these pesticides prior to use. If a pesticide is no longer registered it is no longer legal to use it. A pesticide should not be used on any crop unless it has been registered for that crop.

Pesticides with a temporary registration in 1985 and listed in this publication include Ambush, Decis, Lorsban, Ripcord, Thuricide HPC.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled onto clothing or parts of the body remove clothing including under-garments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibity symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from the list mentioned above or use this book for reference.

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted in the following manner:

> Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone (416) 965-3610.
>
> During weekends, public holidays and non-office hours telephone (416) 965-1211 and ask for the "on-call" physician.

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CORN

CROP MANAGEMENT

Seeding Date and Planting Depth Optimum seeding date centers on May 7 in southwestern Ontario, and May 10 in central and eastern Ontario. Those seeding earlier commonly must contend with lower soil and air temperatures. Studies show there is a relationship between emergence, temperature, and depth of seeding. Early seedings should be sown shallow (3 to 5 cm at a maximum). If they are sown deeper, a delay and reduction in emergence can occur. The result is an uneven stand. For later seedings (temperature is warmer) there may be a slight slowing of emergence for deeper plantings but the reduction in stand likely will be small.

Seed Size All seed sold for plate-type planters is sized in three dimensions; length, width and thickness. Although there are a large number of different seed sizes for any one hybrid, all bags of seed sold have a recommended seed plate for the specific size of seed in the bag for most common makes of plate planters. With plate planters, the desirable situation is to have one seed in each cell of the plate with no misses, no doubles and no split seed. However, one way to check that you are getting the desired plant stands is to calibrate your planter on a hard surface at field speed. With plateless planters, manufacturers' instructions should be followed to ensure accurate seeding rates with all seed sizes. All seed sizes within a hybrid are identical in terms of genetic potential. There is no evidence that large seeds of one hybrid will produce larger plants and thus more yield than smaller seeds of the same hybrid.

Plant Populations A final plant populations of 50,000 to 62,000 plants per hectare is recommended, irrespective of the row width used. However, on making a final decision on what plant populations to aim for, several additional factors should be considered.

1. The final plant stand should be 50,000 plants per hectare where the yield levels have tended to be low and plant lodging is a problem. On soils that are low in fertility, susceptible to drought, or imperfectly drained, the lower populations are well worth considering. The population should also be lowered under late planting conditions.
2. Consideration should be given to increasing plant density up to 62,000 plants per hectare on farms with a history of high yields and low plant lodging. On fertile, well-drained soils with high moisture-holding capacity, an increased plant density is most likely to return dividends. Higher plant populations are more often warranted in the shorter season areas (less than 2900 heat units), and under conditions where corn is planted early.
3. Consideration may be given to increasing plant populations in corn that is being produced for whole plant silage to between 62,000 and 70,000 plants per hectare. These higher populations have given highest yields in Ontario research trials, with no effect on grain content or dry matter percentage of the silage. Populations above 62,000 plants per hectare should not be used on droughty soils, when the crop might be harvested for grain, or in regions with 3100 or more heat units. Increased populations will lead to greater stalk breakage for corn that is being produced for grain. This will not occur in corn harvested for whole plant silage because corn silage is harvested at an earlier stage for growth.

The reason for increasing plant density is to try and realize a higher harvested yield per acre. However, as the plant density is increased, the plants are under greater stress since there are more plants competing for the moisture, fertility and light available. With denser plant stands any additional stress such as drought, low fertility, weed competition, insects or diseases will have a more detrimental effect on grain yield, grain quality and lodging. It is quite probable that slight increases in grain yield could be lost at harvest-time due to increased harvesting losses resulting from smaller ears and more lodging.

Table 1 gives the distance between seeds required to achieve a specified populations.

Table 1. Centimetres Between Seeds to Achieve Specific Populations

Final[1] Plants/ hectare	Seeds[2] Per hectare	Row Width[3] - centimetres						
		71	76	81	86	91	97	102
40,000	43,900	32	30	28	26	25	23	22
45,000	50,000	28	26	25	23	22	21	20
50,000	55,600	25	24	22	21	20	19	18
55,000	61,100	23	22	20	19	18	17	16
60,000	66,700	21	20	19	17	16	15	15
65,000	72,200	20	18	17	16	15	14	14
70,000	77,800	18	17	16	15	14	13	13

[1] *hectare* = 2.47 acres

[2] *Based on 10% loss of plants. With planting after the optimum date, a loss of 5% of the plants may be more realistic.*

[3] *1 centimetre* = 0.39 inches

HYBRID SELECTION

1986 Recommended Hybrids Corn hybrids suitable to Ontario conditions are listed in the *1986 Ontario Hybrid Corn Performance Trial Report.* Growers are strongly advised to consult this report for information on the performance of recommended hybrids for their specific heat unit area.

Choosing Hybrids For Your Farm By Heat Units Locate the vicinity of your farm in Figure 1 and estimate the heat unit rating for your farm. If your plant corn BEFORE mid-May, choose a hybrid from among those on the recommended list having EQUAL or LOWER rating than your farm.

If soil conditions or any other factor on your farm usually DELAY planting later than mid-May, then for a DELAY of one week or more, DEDUCT 100 heat units for EACH week from the rating for your farm and select hybrids from the list having that rating, or a LOWER rating.

Research and experience have demonstrated that hybrids producing high grain yields also produce high silage yields.

FERTILIZERS FOR CORN

Soil Testing

Fertilizer requirements for corn in Ontario can best be estimated by using a soil test along with information on past management. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes), annual testing is advisable as potash soil tests can change rapidly under those conditions.

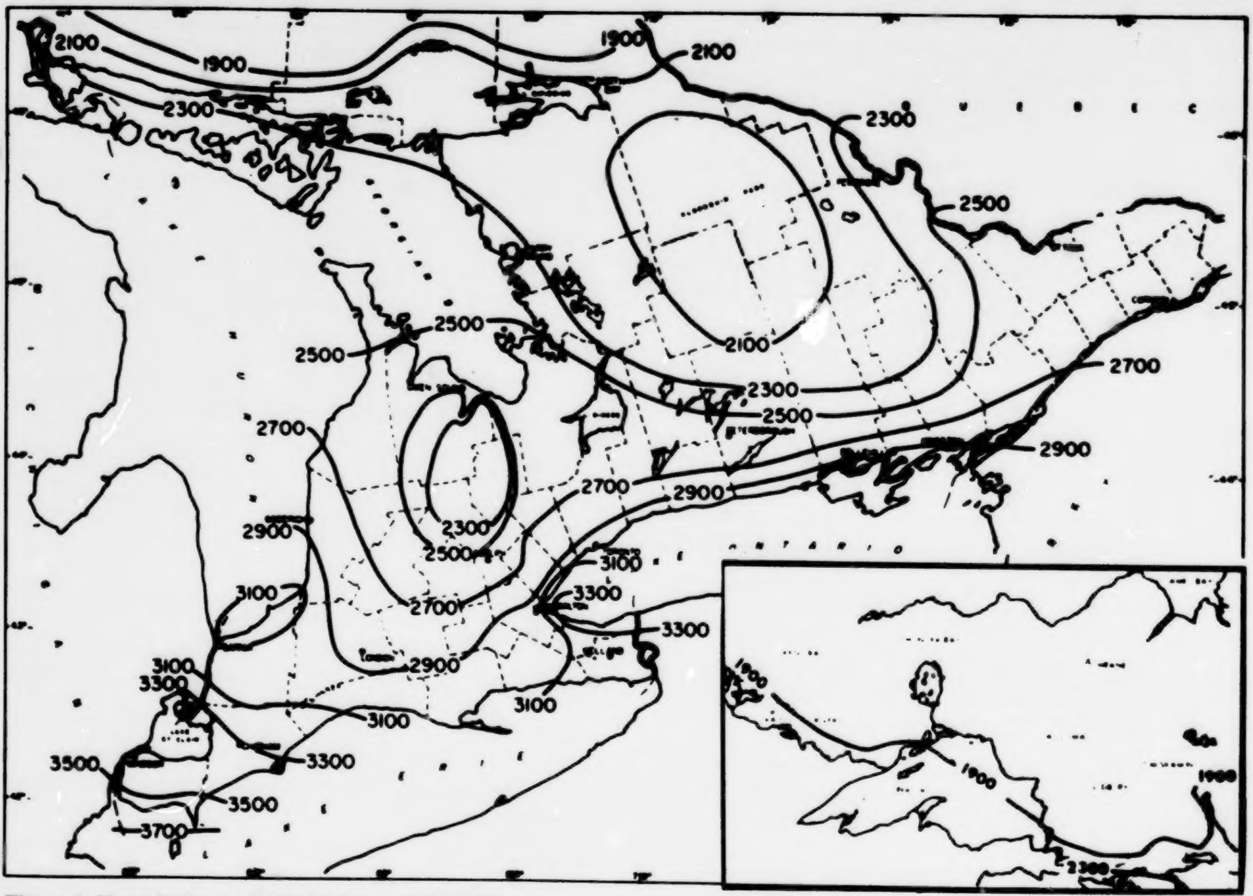


Figure 1. Heats Units Available for Corn Production

Plant Analysis

Plant analysis is a useful supplement to soil testing for evaluation of fertilizer requirements and for diagnosing nutrient deficiencies of corn. It is quite independent of soil testing and for phosphorus, potassium, magnesium and manganese it is a very useful "second opinion". For nitrogen and zinc it has not been very reliable. For boron and copper we do not have a reliable soil test, so, plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately.

For corn the mid-third of the ear leaf at silking is recommended. However, plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants with six leaves or less sample the total above ground plant. From seven leaves to silking sample the youngest fully developed leaf. Expert help will be required to interpret plant analysis results when the samples are not taken at silking.

A soil sample should be taken from the same area and a the same time as a plant sample.

For more information on plant analysis see *Plant Analysis Section* in *Soils.*

Table 2. Interpretation of Plant Analysis for Corn[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen	%	2.5	3.5
Phosphorus	%	0.15	0.50
Potassium	%	1.2	2.5
Calcium	%	—	1.5
Magnesium	%	0.10	0.60
Sulphur	%	0.14	—
Boron	ppm (ug/g)	2	25
Copper	ppm	2	20
Manganese	ppm	15	150
Zinc	ppm	14	70

[1] *Values apply to the mid-third of the ear leaf sampled at silking.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for corn are, therefore, based on the region of the province and the expected yield and adjusted downward if manure is applied or if the previous crop contains perennial legumes such as alfalfa.

Nitrogen (N) Requirements for Corn in Southwestern Ontario

The most profitable rate of nitrogen application is affected by the market price of corn relative to the cost price for nitrogen as expressed by the price ratio of corn to nitrogen. Table 3 shows the relationship for the counties of Essex, Kent and Lambton and for the clay and clay loam soils of Huron, Perth, Middlesex and Elgin.

Table 3. Prices of Common Nitrogen Fertilizers Corresponding To Fixed Prices for Nitrogen (N)

Nitrogen[1] N$/kg	Anhydrous Ammonia (82% N)	Urea (46% N)	28% Solution (28% N)
	Dollars per Tonne		
0.40	328	184	112
0.50	410	230	140
0.60	492	276	168
0.70	574	322	196
0.80	656	368	224
0.90	738	414	252

[1] $$\text{Cost of Nitrogen (N) \$/kg} = \frac{\text{Cost of Nitrogen Fertilizer in \$/Tonne}}{\text{\% Nitrogen (N) in the Fertilizer} \times 10}$$

Table 4. Relation of Corn and Nitrogen Prices to the Most Profitable Sidedressed Nitrogen Applications for Southwestern Ontario[1]

(The Counties of Essex, Kent and Lambton and clay and clay loam soils in Elgin, Huron, Middlesex and Perth)

Price Ratio	Expected Yield[2] — t/ha grain (silage)				
	6 (30)	7 (35)	8 (40)	9 (45)	10 (50)
	Most profitable nitrogen application[3] kg N/ha				
100	75	80	90	95	105
200	115	125	140	150	160
300	135	150	165	185	200
400	145	160	180	200	220

100 kg/ha = 90 lb/ac.

[1] *To use the table, the price of corn must be known or estimated. Corn at $105/t and nitrogen at $0.70/kg results in a price ratio of 150 (105 ÷ .70). At these prices and an expected yield of 7 t/ha you should use approximately 100 kg N/ha.*

[2] *Expected yield is that yield which from experience you expect from your soil, climate and management.*

[3] *Nitrogen rates presented are for sidedress application. For preplant application an additional 30 kg N/ha should be applied. Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (See Nitrogen Adjustment for Legumes Plowed Down section), or if manure is applied (See Manure Section in Soils).*

Table 5. Nitrogen (N) Requirements for Corn in Eastern and Central Ontario and sandy loam, loam and silt loam soils in Elgin, Huron, Middlesex and Perth Counties[1]

Expected Yield[1],[3] Shelled Corn	Silage Corn	Nitrogen[2],[3] (N) Required
t/ha	t/ha	kg/ha
5	25	80
6	30	100
7	35	120
8	40	140
9	45	160

[1] *Expected yield is that yield which your experience indicates you should obtain under your conditions of soil, climate and management.*

[2] *Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (see Nitrogen Adjustment for Legumes Plowed Down section) or if manure is applied (see Manure Section in Soils).*

[3] *1 t/ha = 0.45 ton/ac = 16 bu/acre 100 kg/ha = 90 lb/ac*

Phosphate and Potash

Phosphate and potash requirements for corn are presented in Table 6. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food (OMAF) soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Table 6);

b. If the field has received little fertilizer in the past, use one of the rates recommended for LOW soil test rating (see Table 6).

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Table 6. Phosphate and Potash Requirements for Corn Based on OMAF Soil Tests

Soil test	Rating	Phosphate (P_2O_5)[1] required — kg/ha	Soil test	Rating	Potash (K_2O)[1] required — kg/ha
0 - 3		110	0 - 15		170
4 - 5	LOW	100	16 - 30	LOW	160
6 - 7		90	31 - 45		140
8 - 9		70	46 - 60		110
10 - 12		50	61 - 80		80
13 - 15	MEDIUM	20	81 - 100	MEDIUM	50
16 - 20		20	101 - 120		30
21 - 30	HIGH	20	121 - 150	HIGH	0
31 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61+	EXCESSIVE[2]	0	251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

[1] *Where manure is applied reduce the fertilizer application according to the amount of quality of manure (see Manure section in Soils) Example of fertilizer application: If the expected yield of corn grain in a particular field in Oxford County is 7 t/ha, the nitrogen recommendation would be 120 kg/ha (see Table 5). If the soil tests are 11 for phosphorus and 110 for potassium, the phosphate requirement is 50 kg/ha and the potash requirement 30 kg/ha (from above table). The phosphate can be supplied by 160 kg/ha (50 ÷ 32 x 100) of 8-32-16 applied 5 cm to the side and 5 cm below the seed at planting. It would supply 12 kg nitrogen and 25 kg potash/ha. The remaining 108 kg N/ha can be supplied with 130 kg (108 ÷ 82 x 100) kg of 82-0-0.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may induce zinc deficiency on soils low in zinc and increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Micronutrients and Magnesium

Although magnesium is plentiful in most soils in Ontario, magnesium deficiency does occur on acid, sandy soils. The symptoms appear first as yellow striping of the lower leaves. As the deficiency worsens, the upper leaves may become striped while the lower leaves turn reddish-purple.

All soil samples analysed under the OMAF soil testing program are tested for magnesium. This test is a reliable guide for determining magnesium requirements.

Dolomitic lime is an excellent source of magnesium. Where limestone is required to correct soil acidity, dolomitic lime should be used whenever the magnesium test is less than 100. For further information, see OMAF Factsheet, *Soil Acidity and Liming*, Agdex 534.

Few soils that do not need lime will require magnesium. Magnesium application is recommended only if the magnesium test is under 20. On these soils, magnesium can be supplied either by magnesium sulphate or, if potassium is also required, by sulfate of potash magnesia. Apply 30 kg/ha of water soluble magnesium.

Over-application of potassium can induce magnesium deficiency. For this reason it is important to monitor soil potassium levels closely, and restrict potash application rates to those recommended by the OMAF soil test.

Zinc deficiency occurs on corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Response to zinc should not be expected unless deficiency symptoms are quite marked.

When zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 14 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at planting. Zinc may be applied as a foliar spray at rates supplying 60 g zinc/100 litres (0.6 lb/100 gal). A wetting agent should be added. Spray to leaf wetness. For further information, *see Micronutrients in Soil Management* section and OMAF Factsheet, *Zinc Requirements for Field Crops*, Agdex 100/531.

Other micronutrients are not likely to be deficient on corn in Ontario.

Methods of Application

Nitrogen should be applied in the spring with the major portion either as a preplant application or side-dressed before the corn is 30 cm high. Fall application of nitrogen is not recommended. In Essex, Kent and Lambton Counties and on the clay and clay loam soils of Huron, Perth, Middlesex, and Elgin, preplant applications of nitrogen have not been as efficient as side-dressed applications. For preplant application an additional 30 kg N/ha should be applied. On these soils in this area anhydrous ammonia has produced 3-5% higher yields than ammonium nitrate or urea. In the remainder of Ontario, preplant application is equal to side-dress application, and there is no yield advantage for anhydrous ammonia over ammonium nitrate or urea.

Solid forms of nitrogen or 28 to 32% solutions may be applied to the surface of the soil without incorporation (However, urea applied on crop residues should be incorporated into the soil immediately). Under dry conditions the effectiveness of all forms of nitrogen fertilizer solutions contact leaves, burning and yield reductions are likely to occur.

Anhydrous ammonia, applied with conventional equipment, should be placed a minimum of 15 cm deep in the soil. For preplant applications, ammonia outlets should be no more than 50 cm apart. For wider spacings, a 4 day waiting period before planting is recommended to avoid damage to the seedlings.

When appropriate equipment is used, ammonia may be applied with a cultivator or disc a minimum of 10 cm deep with the ammonia outlets spaced no more than 50 cm apart.

The major portion of the phosphorus and potassium may be broadcast and plowed or worked into the soil either in the fall or spring. However, where soil tests show a requirement for these nutrients a fertilizer containing nitrogen and phosphorus or nitrogen, phosphorus and potassium should be applied as a starter at planting time. The starter fertilizer should be applied in one of two ways:

1. In a band 5 cm to the side and 5 cm below the seed. The rate of application in the side band should not supply more than 55 kg of nitrogen per hectare or a total of 90 kg of nitrogen plus potash (K_2O) per hectare in one metre rows. If urea is the nitrogen source, not more than 30 kg of nitrogen or 60 kg of nitrogen plus potash per hectare in one metre rows.

2. In a band directly with the seed. With this placement not more than 7 kg nitrogen plus potash (K_2O) per hectare should be applied in one metre rows. Neither urea nor diammonium phosphate should be applied with the seed.

To Calculate Nitrogen and Potash Content

100 kilograms 6-24-24 per hectare provides 6 kg nitrogen and 24 kg potash for a total of 30 kg.

200 kg 8-32-16 provides 16 kg nitrogen and 32 kg potash for a total of 48 kg.

DISEASE AND INSECT CONTROL IN CORN

(see also Pesticides section)

Seed Treatment)

Follow the precautions under *Seed Treatments* in *General Information on Pesticide Usage* section, when applying chemical seed treatments.

Seed corn sold in Ontario has been treated with a fungicide, such as captan, Vitaflo 280 or thiram, for protection against **seed decay** organisms. A treatment may also have been applied to control insects that attack seed in storage. Additional treatments to protect seeds from soil-inhabiting insects should be applied every year. Use diazinon to reduce damage by **seed maggots** and lindane for protection from **wireworms.** Seed treatment combinations of diazinon and lindane are available from seed suppliers and should be applied as recommended. Follow the directions on the label with care. Thorough mixing is important.

Apply insecticides to the seed just before planting or mix them with seed in the planter box. Use a wooden paddle to mix the chemicals and seed.

DISEASES

General Preventive Measures

1. Plant hybrids resistant to leaf blights and stalk rot (see below and check with seed company).
2. Rotate corn with other crops to help prevent disease buildup. Rotation is particularly important when reduced tillage is practised.
3. Chopping of corn stalks and leaves, and plowing under of the residues, help to kill overwintering disease fungi.
4. Minimize plant stress by:
    a. Avoiding plant populations that are too high for the hybrid grown.
    b. Maintaining high soil fertility, good soil structure, and good drainage.

Leaf blights Northern leaf blight and leaf spot sometimes appear especially on lower leaves. Both diseases are favored by moderate temperatures, long dew periods, and rain. Most recommended hybrids have good resistance. See OMAF Factsheet, *Leaf Diseases of Field Corn,* Agdex 111/632.

Eyespot is usually severe only in wet seasons in fields with much corn debris from the previous season or on highly susceptible hybrids. Crop rotation and clean plowing of corn debris help to reduce disease severity.

Anthracnose is now widespread in southern Ontario and may become severe in wet years. The disease may affect both leaves and stalks. Rotation of corn with other crops and plowing down corn residues cleanly will reduce disease severity. See OMAF Factsheet, *Leaf Diseases of Field Corn,* Agdex 111/632.

Bacterial leaf blight (Stewart's Wilt) occurs in southwestern Ontario, mainly in Essex and Kent counties. Elongate water-soaked streaks with wavy margins appear on the leaves, especially after silking. When disease develops earlier the plants may wilt. The disease can be transmitted in seed or by the corn flea beetle, and may spread from sweet corn which is more susceptible than field corn.

Stalk Rot Grow hybrids with low stalk breakage counts, as listed in the current Ontario Hybrid Corn Performance Trials. Copies are available from your county office of the Ministry of Agriculture and Food. Stalk rot is often serious in fields with high plant populations, low fertility, and poor soil conditions. Harvest as early as possible because stalk rot develops mostly on mature plants and becomes a greater problem the longer the crop is left in the field.

Ear Rot Pink, white green and black molds may develop on ears. The pink molds, and less often the white molds, may produce toxins, including estrogens and vomitoxin, which have serious effects on livestock, especially pigs and poultry. The green and black molds do not normally pose a problem except when, in great abundance, they may put livestock off feed. Development of the ear rot is stopped when corn is dried, or ensiled, but the level of harmful toxins, if present, remains unchanged. Where corn is stored in cribs these fungi will, under favorable weather conditions, continue to grow and produce toxin until corn moisture drops below 20%. See OMAF Factsheet, *Moldy Feeds and Swine Diseases,* Agdex 440/60.

Storage and Feeding Precautions

1. Exercise caution in feeding moldy corn, especially to hogs. Pink or reddish molds are particularly harmful.
2. For assistance with problems of moldy feeds, contact the county office of the Ontario Ministry of Agriculture and Food. It may be recommended that the feedstuff be analyzed for toxins.
3. Avoid cribbing corn with pink ear rot.

Head Smut This disease was first observed in Ontario in 1979. Incidence of head smut in field corn has been low since 1980. However, spores of the head smut fungus survive in the soil for several years. This disease is easily confused with common smut but is much more destructive. Recommended hybrids differ in degree of resistance to head smut. Consult OMAF Factsheet, *Head Smut of Corn,* Agdex 111/632 for further details of the disease.

INSECTS

Corn Rootworms There are two species of corn rootworms that damage corn in Ontario. The northern corn rootworm is still the predominant species east of Oshawa, while the western corn rootworm is the predominant species west of Oshawa.

The larval stage of these species feed on corn, causing damage by tunneling through and pruning roots from mid June to mid July. When fully grown the slender, white larvae are about 1.5 cm long. The northern adult is a plain yellow or green beetle about 0.5 cm in length; the western adult is yellow with black markings and is slightly larger than the northern adult. Both adults feed on corn silks from August to the first frost. See OMAF Factsheet, *Corn Rootworms,* Agdex 111/622.

Crop rotation is recommended to control both species of rootworms. If crop rotation is not practical and the western corn rootworm is predominant in your area, it may be necessary to treat 2nd-year corn, especially on clay soils. Historically, it has not been necessary to treat 2nd-year corn where the northern species predominates. If extensive goosenecking occurs, consider treatment with insecticide the following spring. Use a planter-mounted granular insecticide applicator with a spreader attachment to place an insecticide in at least a 15-cm band in front of the press wheel but not in contact with the seed because of possible phytotoxicity. Calibrate the applicator each year and when switching chemicals or changing planting speed. Do not use a broadcast application. To avoid wind drift and poor control, mount the spreaders as close to the ground as possible, and use wind guards. Any one of the following insecticides may be used. Consult the insecticide label for manufacturer's directions for use.

Poor control has often been the result of:

1. Poor calibration.
2. Applying less than recommended rates.
3. Poorly maintained equipment.
4. Absence of wind guards for proper placement of insecticide on windy days.

Under light to moderate rootworm pressures all of the insecticides listed below have significantly reduced the damage caused by corn rootworms. Under heavy insect pressures the approximate order of effectiveness is as listed below.

Table 7. Corn Rootworm Control

	Rate of Product		
Insecticide[1] Applied in a 15-cm band	**Grams per 100m of row Any Row Width**	**kg/ha at Row Width of 90 cm**	**75 cm**
Counter 15 G[2]	75	8.3	10.0
Dyfonate 20 G[3]	55	6.1	7.3
**Lorsban 15 G[4]	75	8.3	10.0
Thimet 15 G	75	8.3	10.0
Furadan 10 G	110	12.2	14.6
Di-Syston 15 G	75	8.3	10.0
720 LC[5]	15 mL	1.66 L/ha	2 L/ha
Dasanit 15 G	75	8.3	10.0

G (Granular); LC (Liquid Concentrate).
** *See "Temporary Registration of Pesticides" inside front cover.*

[1] There is concern that the continued use of one material may result in development of corn rootworms resistant to, or soil microorganisms capable of rapid degradation of, that insecticide. All of these insecticides are extremely poisonous to the operator. Handle with care. Follow all safety precautions on the label. Only purchase what is needed for one year. Store under lock and key and not with food or animal feed. For additional information see Pesticides section.

[2] Also controls seed corn maggot and wireworms.

[3] Also controls seed corn maggot.

[4] Placement behind the planter shoe and ahead of the press wheel improves performance.

[5] Liquid concentrate must be sprayed in a 15-cm band for control. Do not apply with liquid starter fertilizer because the band is not wide enough for control of rootworms.

European Corn Borer The stalk breakage problem in any year cannot be predicted but will depend on many factors including weather conditions, stalk rot, wind and borers.

The cream-colored female moth usually lays her eggs on the underside of corn leaves, beginning in early June in southwestern Ontario and somewhat later in other parts of the province. After hatching, the young borers feed on the leaves, giving them a pinpricked appearance. Sometimes the feeding scars are elongate. Later, the borers work downward into the "throat" (whorl) of the plant and feed on the developing leaves. Afterwards, they enter the stalk. Control is effective only if the borers are destroyed before they enter the stalk. It is most important to select a hybrid with good standability and thus some resistance to breakage. Avoid plant populations that are too high for the hybrid grown. Higher plant populations lower stalk quality and can result in more breakage. In additions, growers should plant as early as feasible to reduce the infestations by the second generation where it occurs, and to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to decrease losses from dropped ears and broken stalks which occur during autumn storms.

European Corn Borer Strains There are two distinct strains of the European corn borer in Ontario. Most areas have the strain with a single generation per year, but south of a line from Sarnia to London and Simcoe, the strain has two generations per year. There is some resistance to leaf feeding by the single-generation strain and the first generation of the two-generation strain, but none by the second generation feeding where it occurs. The resistance ratings, as such, are not available but are reflected, among other factors, in the standability ratings available in the current Ontario Hybrid Corn Performance Trial Report.

Two-Generation Area In the southwestern area where the two-generation strain occurs, the second generation is larger than the first, is more abundant in late-planted corn, and is responsible for most of the ear loss due to damaged shanks and stalks. For this reason the non-chemical recommendations listed above are generally preferable. If insecticides are applied, use a material listed below but apply it in August against the second generation. Eggs for this generation are laid over a three-week period. Probably more than one application would be required for significant control.

One-Generation Area Where only one generation occurs, loses can be high enough to warrant control. You should examine the plants for borer feeding before tassels show in the whorl or when plants are about 60 cm tall. Examine the plants at 10-day intervals and spray if you find that more than 50% of the plants have feeding scars. Two applications, 7 to 10 days apart, may be needed for significant control. Once the larvae bore into the stalks, treatments are not effective and should not be applied. In some years the one generation strain produces a partial second generation. This flight is usually small and occurs towards the end of August. It does not pose a serious threat to corn. For further information, see OMAF Factsheet, *European Corn Borer*, Agdex 111/622.

Table 8. European Corn Borer Control

Insecticide	**Formulation[1]**	**Product per ha**
*Furadan	480 F	1.1 L
Sevin XLR[2]	480 Su	2.5-4.0 L

[1] *F (Flowable); Su (Suspension)*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

* *Minimum period before re-entry is 48 hours. See Reentry into Treated Areas.*

Bees often visit sweet and field corn to collect pollen. Where spraying is being done bee poisoning may result. **Sevin and Furadan are highly toxic to bees** but Sevin is the most damaging since it is carried to the hive and poisons the brood. If bees are in the area, advise local keepers of spraying activity and do not use Sevin. You local agricultural representative has a listing of beekeepers in your area. Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid contamination of roadsides and adjacent fields where plants may be in bloom.

Cutworms They are found in the soil and attack seedling corn in the two-to-five-leaf stage. Plants suddenly wilt because the stem is hollowed out or cut off at or just below ground level. The cutworms can usually be found in the soil within a few centimetres of damaged plants. There are a number of species of cutworms and they may be gray to dark brown in color and striped or mottled. Mature cutworms are about 3.5 cm long. Cutworms that are nearly mature (over 2.5 cm long) are difficult to control but they will stop feeding in a few days when they reach full size. Insecticide application is not recommended in this case because most of the damage is done and it is better to wait a few days and replant. Treatment is most effective when applied soon after cutworms have hatched. Only a small acreage of Ontario corn has cutworms problems any one year. For this reason, and because corrective sprays are available, granular treatments applied at planting time are not recommended.

If seedling corn is attacked and the cutworms are small, apply one of the following treatments in 400 L of water per hectare at the seedling (2- to 5-leaf) stage when damage first appears. Cutworms are most active in the evening and treatments are best applied at this time.

Table 9. Cutworm Control[2]

Insecticide	Formulation[1]	Product/ha
**Ambush[3]	500 EC	225-300 mL
Lorsban	4 E	2.4 L

[1] *E or EC (Emulsifiable Concentrate)*

[2] *Seedling stage only.*

[3] *Read the label. Do not disturb the soil for 5 days after application.*

***See "Temporary Registration of Pesticides" inside front cover.*

Armyworm Because weed-infested corn is attractive to armyworm moths for egglaying, eliminate grasses and weeds from the corn crop. The result will be less armyworm damage to corn (see Ontario Ministry of Agriculture and Food Publication 75, *Guide to Chemical Weed Control*). When armyworms move into corn fields, spray the border rows and adjacent cereals, pasture, or hay crops. Refer to Armyworms in Cereals section for more information.

Potato Stem Borer This pest of corn is more severe in the eastern counties of Prescott, Glengarry, Russell, Stormont, Carleton, Dundas and Renfrew, but infestations have been found throughout Ontario.

Seedling corn is destroyed by larvae (pinkish worms 4 cm long when mature) that bore into the base of plants just below or above ground level. The leaves of infested plants wilt and turn brown from the tips downward. Seedlings up to 40 cm high wither and die. Such plants break off at ground level when pulled. The worm may be found in the stalk or in the soil near the base of the plant. The larvae move to corn in late May or early June from grassy field borders.

At present there are no effective insecticides to control the potato stem borer in the corn. To reduce potato stem borer infestations, maintain weed-free fields and borders by plowing, cultivation and with the use of herbicides as outlined in OMAF Publication 75, Guide to Chemical Weed Control.

The primary weed hosts are perennial grasses and these must be killed in the fall or early enough in the spring to prevent the survival of borers. Herbicide treatments later than May 1st will probably do more harm than good. Evidence suggests that such treatments fail to kill borers but cause them to move to corn sooner. Where the potato stem borer has been troublesome in the past, doubling the plant stand by over-planting the border rows can help by compensating for seedling mortality.

Corn Leaf Aphid These small dark aphids do not overwinter in Ontario. Each year they are carried into the province by air currents. Populations of 400 or more per plant, especially under dry conditions, may be economically important. See OMAF Factsheet, *Corn Leaf Aphid*, Agdex 111/622.

White Grubs The larvae of June beetles have plump, white bodies with large brown heads and six prominent legs. They are found in a "C"-shaped position in the soil near the roots of plants. The adults lay their eggs in sod and white grubs are therefore a problem in corn following sod, particularly in run-down fields or pastures. When such fields are plowed, the partly grown larvae can be found, especially if the sod is broken apart and examined carefully.

Sap Beetles They are small dark beetles about 6 mm long with two yellow spots on each wing cover. These bettles are often numerous in corn fields but do not cause significant damage. For more information see Ontario Ministry of Agriculture and Food Factsheet, *Sap Beetles on Raspberries, Tomatoes and Corn*, Agdex 675.

Insects in Stored Grain

Stored Grain Insects - Surveys have shown that stored grain in county elevators and on farms in Ontario have the heaviest insect infestations of any region in Canada. **This situation must be corrected.** See section *Insects in Farm Stored Grain* under Cereal Crops, Insect Section.

WEED CONTROL IN CORN

For weed control recommendations see OMAF Publication 75, *1986 Guide to Chemical Weed Control*.

FORAGE CROPS

Hay and pasture occupies 1.7 million hectares or approximately 38% of the improved land in Ontario. In addition to their time honoured role of providing economically most of the protein and much of the energy for ruminant livestock, the grasses and the legumes are now regaining prominence in the role of soil conservation.

CROP MANAGEMENT

Soils for Forages Forages in general are adapted to a wide range of soil types and soil conditions. Each of the species, however, has its own specific soil requirements for optimum production and persistence. Most species prefer well-drained, alkaline soils. See the section on species description, and choose carefully. Certain soil factors may be modified to meet the requirements of the preferred forage species.

Forage Mixtures Usually, forages are sown as mixtures of legumes and grasses. The legumes contribute high protein and the ability to gather nitrogen; grasses are more tolerant of adverse conditions, more persistent, an insurance factor. Under good management, a simple mixture of one adapted legume and one compatible grass is usually most productive. There may be situations, for example in long-term pastures or in erosion control, where more complex mixtures are advisable. Seeding a pure stand of a legume or a grass can be recommended for specific purposes. Pure stands are used for seed production; for production of high protein feed through use of a legume; for forage production where no legume is well adapted to conditions.

Seed Quality Seed quality is important. Sow certified #1 seed to be sure of variety, germination and reasonable freedom from weed seeds.

Legume Inoculation Legume seed should always be inoculated with rhizobium bacteria culture before sowing. Alfalfa, trefoil, and clover each require a specific rhizobium strain. The inoculant must be alive; note expiry date and storage requirements on the packet. Seed coated in the current season is a good method of inoculation.

Time of Seeding Chance of success is highest with early spring seedings. Summer seeding, as late as mid-August, will succeed if moisture is adequate. While fall seeding of grasses may be successful, legumes sown in the fall rarely survive the winter.

Seeding Rates The amounts of seed recommended in Tables 12, 15, 18, 19, 20, 23 and 24 for single species and for mixtures are intended for average to good conditions. When seeded early on a fine firm seedbed, with adequate moisture, these rates may be reduced by 25%. When coated seed is used, these rates should not be reduced because of the fewer seeds per unit weight.

Depth of Seeding Forage seed should be seeded shallowly, (no more than 1 cm deep, depending on moisture), into a firm, fine seedbed.

Direct Seeding or Companion Crop Research has shown that direct seeding without a companion grain crop is the best method of establishing a forage crop for most situations because it reduces competition for light, moisture and nutrients. One or two cuts of forage in the year of seeding are possible. Weeds may be a greater problem where a companion crop is not used. Refer to OMAF Publication 75, *Guide to Chemical Weed Control*, and to OMAF Factsheet, *Successful Forage Establishment*, Agdex 120/22.

Fertilizers At time of seeding, placement of phosphorus fertilizer in a band 5 cm below the seed promotes rapid growth. Established forages require adequate fertilization for yield and persistence. Refer to section on *Fertilizers for Forages*.

Harvest Management Optimum harvest dates for forage harvest are a compromise between needs for quality, yield, and persistence. While dry matter yields increase, digestibility and protein decrease as the crop matures. All perennial forages, but legumes in particular, require a period of growth in late summer without harvesting to build up root energy reserves for winter survival. The "critical harvest dates" for alfalfa and trefoil vary with the length of the growing season, and are shown in Figure 2.

The general recommendation is to harvest at bud to 1/10 bloom for legumes, and at the boot to heads emerging state for grasses. Avoid harvesting legumes during the critical harvest period. A final cut may be made after the critical date if required for feed. However, it is preferable to leave regrowth to catch snow for winter insulation.

For further information on forage production, refer to the listing of publications and factsheets on page .

LEGUMES

ALFALFA

Alfalfa-based mixtures are intended for use in stored-feed and green feeding programs because they produce more hay, silage or green chop than any other mixture. Given good management including adequate phosphorus, potash and proper cutting management, high yields of quality livestock feed will be produced for up to four years. When used as pasture, these mixtures are for short-term stands only because alfalfa may thin out in two or three years. For the highest production and best persistence, alfalfa mixtures should be used on well-drained soils. This condition does eliminate the economic use of alfalfa on many heavy clay soil types of the clay belt of northern Ontario.

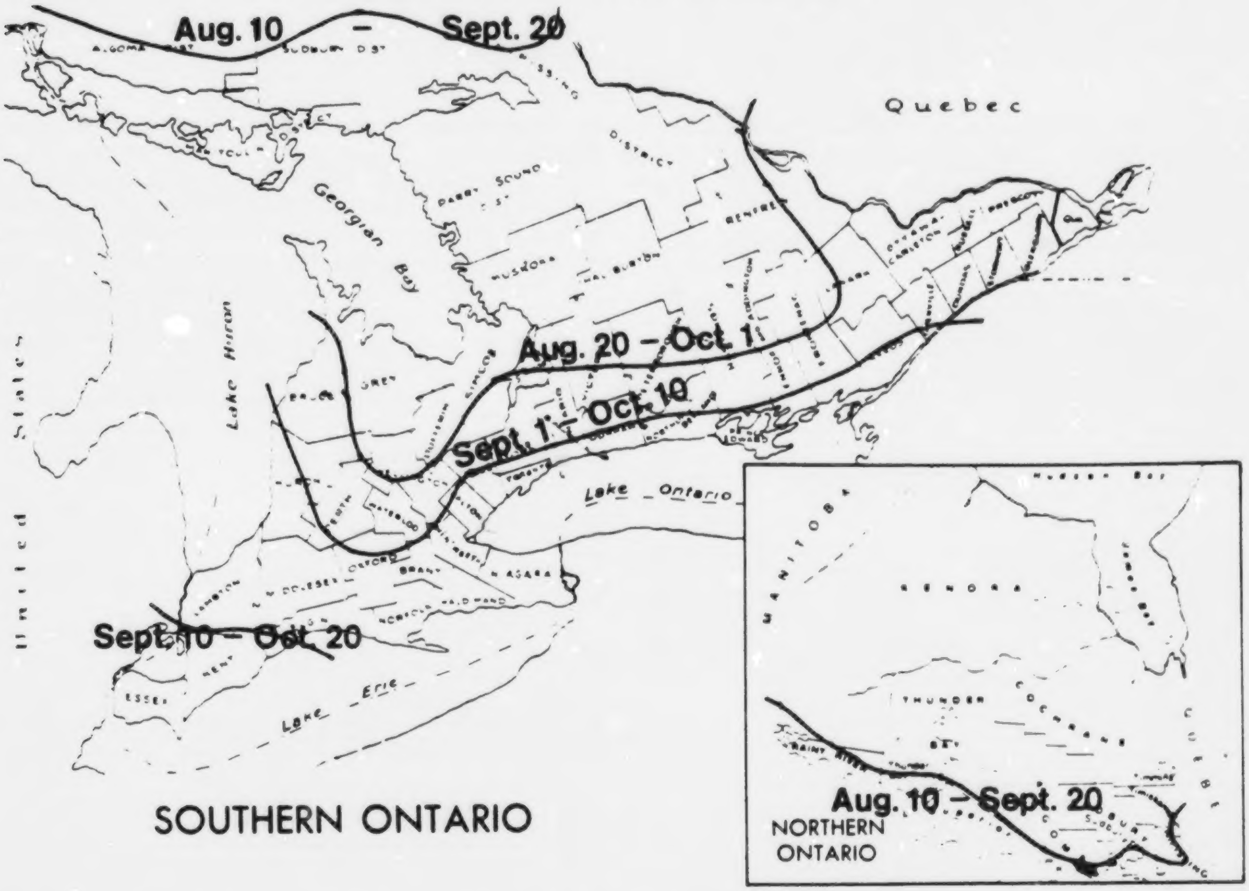
Both early and medium maturing alfalfa-based mixtures can be used on the farm to permit staggering of the harvest dates. The early maturing varieties develop quickly in the spring and provide more and earlier aftermath than medium maturing varieties.

There are no significant differences in protein level between alfalfa varieties. The major factor influencing protein level of alfalfa is the data of harvest. As the plant matures, the percentage of protein decreases. Attempts to develop varieties with a higher protein percentage have resulted in unacceptable lowering of yield.

CROP MANAGEMENT

1. Alfalfa-based mixtures may be seeded with or without a companion crop. Where high forage yields are required in the seeding year **do not** use a companion crop. Weeds must be controlled. When a companion crop is desired use oats at 60 kg/ha preferably in 36 cm rows. Remove the oat crop when knee-high by controlled grazing or at the early dough stage for stored feed if forage establishment is a problem.
2. For stored feed cut at very first flower stage to obtain high quality feed.
3. For pasture, alfalfa must not be overgrazed. Rotational or strip grazing with four- to five-week rest periods improves the persistence of the stand.
4. High soil levels of phosphorus and potassium are required for high yields and maintenance of the stand. See Fertilizers for Forage Crops.

Figure 2. Critical Fall Harvest Dates for Alfalfa


Aug. 10 – Sept. 20
Quebec
Georgian Bay
Lake Huron
United States
Aug. 20 – Oct. 1
Sept. 1 – Oct. 10
Lake Ontario
Sept. 10 – Oct. 20
Lake Erie
SOUTHERN ONTARIO
Aug. 10 – Sept. 20
NORTHERN ONTARIO

To ensure persistence and succeeding yields, do not harvest alfalfa during the critical harvest period shown on the map for each region.

5. Alfalfa is particularly sensitive to cutting or grazing during September and October. Succeeding yields and persistence can be severely reduced if harvests occur during the critical fall harvest.

6. The life expectancy of alfalfa under favorable field conditions varies from two to five years. Long life can be expected where only two harvests as stored feed are taken annually, but a shorter life span is found where aftermaths of hay meadows are grazed or alfalfa is used in pasture mixtures.

ALFALFA VARIETY SELECTION

Table 10. Recommended Early Alfalfa Varieties in Ontario

	Yield (% of Saranac)		Disease Reaction[1]		
Variety	**S. Ontario**	**N. Ontario**	**Verticillium Wilt**	**Phytophthora Root Rot**	**Distributor[2]**
Acclaim	98	—	S	MS	Otto Pick & Sons Seeds
Admiral	101	—	MS	MR	Otto Pick & Sons Seeds
Alouette	98	—	S	S	Otto Pick & Sons Seeds
Anchor	99	97	S	S	Oseco Inc.
Angus	98	100	S	S	Public
Answer	98	91	S	R	Speare Seeds
Apica	105	—	S	S	UCO
Apollo II	98	—	MS	MR	Oseco Farm Seed Centre
Armor	103	—	S	MR	Oseco Inc.
Blazer	101	100	S	MS	Oseco Inc. Jacques Canada Ltd.
Ceres	100	91	S	S	Speare Seeds, King Agro Inc.
Citation	102	108	S	S	Mapleseed Inc.
Classic	100	96	S	S	UCO
DK-135	101	—	MS	MS	Dekalb Cda. Inc.
130	102	—	S	S	Dekalb Cda. Inc.
Excalibur	103	—	MS	S	UCO
Hunter	100	—	S	S	Otto Pick & Sons Seeds
Pacer	99	96	S	S	Bishop Seeds, Oseco Inc., General Seed Co.
Peak	100	—	S	MR	Oseco Farm Seed Centre
88	99	—	MS	MS	Otto Pick & Sons Seeds, Mapleseed Inc.
532	103	—	S	S	Pioneer Hi-Bred
Preserve	102	—	S	MS	Northrup King Seeds
Primal	104	101	S	S	King Agro Inc.
Regal	101	—	S	S	UCO
Saranac	100	100	S	S	Public
Spectrum	100	106	S	MS	Labonte Seeds
Thor	100	98	S	S	Northrup King Seeds
Trident	99	97	S	R	PAG Seeds
Trumpetor	98	100	MS	S	Northrup King Seeds
Turbo	100	—	S	MR	Otto Pick & Sons Seeds
Vista	100	96	S	S	Otto Pick & Sons Seeds
WL316	101	—	MS	S	King Agro Inc., Speare Seeds

Average yield of Saranac in southern Ontario trials 12.4 t/ha; in northern Ontario trials 7.8 t/ha.

[1] *All varieties have resistance to bacterial wilt*

R - Resistant (more than 50% resistant plants)

MR- Moderately resistant (36 to 50% resistant plants)

MS- Moderately susceptible (21 to 35% resistant plants)

S - Susceptible (less than 21% resistant plants)

[2] *See Distributor Address in General Information Section.*

Table 11. Recommended Medium Alfalfa Varieties in Ontario

			Disease Reaction[1]		
	Yield (% of Iroquois)		Verticillium	Phytophthora	
Variety	S. Ontario	N. Ontario	Wilt	Root Rot	Distributor[2]
Algonquin	98	100	S	S	Public
120	105	102	S	MR	Dekalb Cda. Inc.
Glory	103	—	S	S	Speare Seeds
Iroquois	100	100	S	S	Public
Magnum	101	102	S	S	Funk Seeds
OAC Minto	103	106	S	S	Speare Seeds, Bishop Seeds
524	102	89	S	S	Pioneer Hi-Bred
526	103	—	S	S	Pioneer Hi-Bred
Thunder	101	—	S	MR	Oseco Farm Seed Centre
Titan	98	100	S	S	Oseco Inc.
Valor	100	99	S	S	Rothwell Seeds
Vernal	99	96	S	S	Public
WL 222	101	—	S	MS	King Agro Inc., Speare Seeds
Weevlchek	100	90	S	S	UCO

Average yield of Iroquois in southern Ontario trials 12.3 t/ha; in northern Ontario trials 7.4 t/ha.

[1] *All varieties have resistance to bacterial wilt*

R - Resistant (more than 50% resistant plants)

MR- Moderately resistant (36 to 50% resistant plants)

MS- Moderately susceptible (21 to 35% resistant plants)

S - Susceptible (less than 21% resistant plants)

[2] *See Distributor Address in General Information Section.*

Table 12. Recommended Alfalfa-Based Mixtures

Components	Seeding Rate[1] kg/ha	Use Recommendation
Alfalfa alone	13	Use only on fields where alfalfa is known to do well. High levels of fertility are necessary. Harvest at first flower stage and store as haylage or hay. For 20% or higher crude protein feed, harvest when the flower buds appear.
Alfalfa	11	An excellent hay, silage or green chop mixture. Recommended over alfalfa-timothy for farms having more than 3100 heat units and dry soils. Use early or medium-maturing alfalfa varieties.
Bromegrass	9	
Alfalfa	11	Use where aftermath is not required as pasture, but where high quality stored feed is the main consideration. Use this high producing mixture as one of a series to diversify the maturity date of mixtures on the farm.
Timothy	4	
Alfalfa	11	Use on part of acreage where cutting and/or grazing can be matched with maturity of the varieties used. This early maturing mixture demands early cutting for high digestibility and to best utilize the rapid recovery and high aftermath yield. Use early varieties only. Where ladino is adapted, 0.5 kg ladino can be added.
Orchard	6	
Alfalfa	9	For use as part of the pasture acreage or where hay aftermath is to be grazed. Use in combination with mixtures containing orchard to help the pasture production period.
Ladino	2	
Timothy	4	
Bromegrass	9	
Alfalfa	9	Use in conjunction with previous mixture to spread pasture production. Alfalfa, orchard and brome give good production under dry conditions.
Ladino	2	
Orchard	3	
Bromegrass	9	
Alfalfa	9	For use under pasture or hay-pasture conditions. High fertility and good management are necessary for top production. Alfalfa is included as insurance against dry conditions. See white clover-orchard mixtures in *White Clover* section.
Ladino	2	
Orchard	9	

[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used. On farms where these mixtures result in stands with too much grass, reduce the grass seeding rate by up to 50%.*

BIRD'S-FOOT TREFOIL

Under good fertility and well-drained conditions, established trefoil annually produces less forage than alfalfa. However, trefoil stands have been known to be productive for 20 years. The no-bloat feature and natural reseeding abilities makes trefoil an excellent long-term pasture legume.

Trefoil-based mixtures can be used in pasture, stored feed or green chop programs. They should be used only for stands of three or more years duration. Trefoil-based mixtures perform and persist very well on steep, rolling or stoney land, or under wet or acid conditions.

Management

1. Where normal tillage equipment can be used to prepare a seedbed and establish trefoil using the direct seeding method, seed early in spring, do not use a companion crop, control weeds and apply up to 15 kg/ha of nitrogen with the necesary phosphate and potash. (See *Fertilizers for Forage Crops*). On fields which have not previously grown trefoil, inoculation of the seed with rhizobium bacteria is essential. The inoculant must be specific for trefoil, and must be fresh-dated to insure viability.
2. For hay or silage, harvest at the early flower stage of growth.
3. For pasture do not graze until trefoil is 25 to 30 cm high in the spring, except in northern Ontario, where grazing can begin when trefoil is 15 to 20 cm high. For best results use rotational rather than continuous grazing.
4. Trefoil is as sensitive as alfalfa to fall grazings or harvests. Succeeding year's yields are reduced if heavy grazing or harvesting occurs during the critical fall period. (See Figure 2). In Northern Ontario, dates shown for alfalfa may be applied to trefoil. In Southern Ontario, the critical date for trefoil is about 10 days earlier than for alfalfa at any given location.
5. Trefoil stands often require one year following the seedling year to reach maximum productivity. This is particularly true when trefoil is seeded under a companion crop.

Bird's-Foot Trefoil Variety Selection

Four varieties are now recommended in Ontario. These varieties differ in their ability to withstand flooding and poor drainage. They also differ in seeding vigor, growth habit, maturity and hardiness. Differences in yield potential are small and are less significant in variety selections than are differences in drainage tolerance and maturity.

Table 13. Recommended Bird's-Foot Trefoil Varieties

	First Flower						
Variety	**(Guelph)**	**(Kapuskasing)**	**Major Use**	**Regrowth**	**Variable Drainage Tolerance**	**Hardiness**	**Distributor**[1]
Viking	June 15	June 25	Hay	Med	Fair	Good	Public Variety
Maitland	June 16	June 27	Hay	Med	Fair	Good	Mapleseed Inc. Otto Pick & Sons Seeds
Leo	June 23	June 30	Pasture or Hay	Med	Excellent	Excellent	Public Variety
Empire	July 1	July 7	Pasture or Hay	Slow	Excellent	Excellent	Public Variety

[1] *See Distributor Addresses in General Information section.*

Table 14. Bird's-Foot Trefoil Variety Yields

Variety	Yield (as % of Leo) Southern Ontario %	Northern Ontario %
Leo	100	100
Empire	97	94
Maitland	100	92
Viking	101	89

Average yield of Leo in southern Ontario trials 8.8 t/ha; in northern Ontario trials, 6.2 t/ha.

Table 15. Recommended Bird's-Food Trefoil-Based Mixtures

Components	Seeding[1] Rate kg/ha	Expected Life (years)	Use Recommendation
Trefoil Timothy	9 2	5+	For long term pastures, early or late maturing hay. Choose timothy varieties for desired maturity and for drainage conditions. The timothy gives poor summer production.
Trefoil Bromegrass	9 4	5+	For long term pastures and hay production. Gives reasonable yields throughout the season. Graze early to reduce the competition from the brome.
Trefoil Meadow Foxtail[2]	9 10	5+	For extra early pasture production. Graze early to reduce competition from the foxtail and to keep it palatable. Use on wetter fields.
Trefoil Tall Fescue	8 10	5+	For good pasture production throughout the season particularly in the fall. Keeps high feed quality until the late fall.
Trefoil Creeping Red Fescue	8 6	5+	For excellent summer time pasture production. This mixture maintains a good quality value until the late fall.
Trefoil Orchard	8 4	5+	For early pasture production. The grass must be kept grazed down to reduce its competitive ability. Late orchard grass varieties should be used.

[1] *For early seeding on a fine, firm seedbed. These rates may be reduced by 25% except where coated seed is being used.*

[2] *Use coated seed. It can be seeded through the grain seed box.*

RED CLOVER

Red clover-based mixtures are short-term mixtures best used for stored-feed production. Red clover produces well in the year following seeding, but usually thins by the second harvest year and rarely survives for a third harvest year. Timothy is the best grass to use with red clover. Red clover is difficult to cure as hay, but makes excellent haylage. It is not recommended in pasture mixtures because of the bloat hazard and poor persistence.

Red Clover Types

Double-cut or medium red clover is the most popular type with farmers. It will flower in the seeding year and in the first and second cut in the succeeding years. The regrowth after cutting is strong and vigorous.

Single-cut or mammoth red clover is slower growing with larger stems and matures about two weeks later than the double-cut. It does not flower in the seeding year or in the slow growing, low yielding leafy aftermath in succeeding years.

Red Clover Variety Selection

The recommended double-cut varieties of red clover are somewhat more persistent in the second production year than is commercial Canadian double-cut, and are particularly recommended where stands will be harvested for two years.

Table 17. Red Clover Variety Yields

Variety	Yield (as % of Florex) Southern Ontario	Northern Ontario
Florex	100	100
Arlington	96	98
Lakeland	90	95
Ottawa	90	89
Prosper I	97	98

Average yield of Florex in southern Ontario trials 9.5 t/ha; in northern Ontario trials 6.3 t/ha.

Table 16. Recommended Double-Cut Red Clover Varieties

	First Flower				
Variety	(Guelph)	(Kapuskasing)	Regrowth	Variable Drainage Tolerance	Distributor[1]
Arlington	June 15	June 29	Med	Good	Public variety
Florex	June 18	July 2	Med	Good	Northrup King Seeds Otto Pick & Sons Seeds Mapleseed Inc.
Lakeland	June 18	July 2	Med	Good	Public variety
Ottawa	June 18	June 29	Med	Good	Public variety
Prosper I	June 18	July 2	Med	Good	King Agro Inc.

[1] *See Distributor Addresses in General Information section.*

Table 18. Recommended Red Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendation
Red Clover	11	1	Short-term hay, seed and/or plow-down crop. Plow in the seeding or after the first production year. Follow with corn, a row crop or cereals to utilize the nitrogen contributed by the clover.
Red Clover Timothy	7 6	1 to 2	For short-term stands of hay. When clovers disappears, plow, or fertilize with nitrogen in order to maintain production.
Red Clover Alsike Timothy	7 2 6	1 to 2	For short-term hay. Less clover can be expected in the second year. When clovers disappear, plow, or fertilize with nitrogen in order to maintain production. Alsike is more tolerant of acid soils and poor drainage.

[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

Red Clover Plow-down

Plow-down red clover is red clover seeded with or without a companion crop and plowed down in late fall of the establishment year or early the next spring. When used in this manner a full stand 15 cm in height at fall plowing can contribute excellent soil tilth and substantial nitrogen to the following crop (see *Nitrogen Adjustment for Legumes Plowed Down*). By late fall, when seeded under an early-removed, grain companion crop, double-cut red clover can produce two tonnes of top growth and two tonnes of root dry matter per hectare which will average 3% nitrogen. Generally double-cut red clover produces more top-growth than single-cut. Inoculation of the seed with the appropriate Rhizobium culture will ensure the nitrogen contribution.

Red clover has a vigorous seedling which establishes easier than alfalfa. When establishing red clover under spring grain, it is preferable to seed early to avoid lodging of the grain crop and harvest problems. Red clover seed may be broadcast directly or included in the spring application of dry or liquid nitrogen on winter wheat.

WHITE CLOVER

White clover mixtures perform best as pastures, particularly in areas where moisture is plentiful and winterkilling is not a problem. They are difficult to cure as hay. Ladino is the large tall-growing type of white clover, and is the type of white clover recommended in Ontario. It tolerates variable drainage conditions. Because it flowers in early June and regrows rapidly, it performs well in combinations with orchard grass to give an early maturing mixture. Including an early productive grass such as orchard grass in a white clover based pasture mixture can help to reduce the bloat hazard.

Management

1. Control grazing in autumn to leave protective cover for grass leaves on overwintering creeping stems of ladino.
2. Controlled grazing management helps the stand remain productive for a period of years.

White Clover Variety Selection. Sacramento is the ladino type white clover variety presently recommended in Ontario. Distributor for this variety is Tib Szego Associates Ltd.

Table 19. Recommended White Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendations
White clover (Ladino type) Orchard	2 9	3	For pasture use where white clover is adapted. High fertility, adequate moisture, and good management required for top production. In dry areas add alfalfa. See alfalfa ladino orchard mixture in Table 12.

[1] *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

GRASSES

Generally, legume grass mixtures are more productive than grasses grown alone. However, pure grass stands may be more productive than legumes on poorly drained soils, under acid soil conditions, or under climatic or mangement conditions unfavorable to legumes.

Orchard grass, bromegrass, timothy and mixtures of these can be used in areas where early pasture is required.

When cut at the "heads emerging" stage for stored feed, grasses are as high in digestible energy as legumes. If fertilized with nitrogen their crude protein content may range from 12 to 15%. Reed canary grass should be used on very poorly drained areas when long-term stands are desired. All grass stands require nitrogen, phosphate and potash to be productive. (See *Fertilizers for Forage Crops*).

Management

1. Successful seeding of pure grass can best be obtained by seeding in early spring. Use a complete fertilizer (Nitrogen, Phosphate and Potash) at seeding time.
2. Harvest grasses at the "heads just emerged" stage of growth for top quality stored feed. For maximum stand persistence, harvest at heading is recommended.
3. Apply recommended rates of nitrogen early each spring and after each cutting or grazing. See Table 30.
4. Apply phosphate and potash each fall at rates indicated by soil test. See recommendations in *Fertilizers for Forage Crops.*

Table 20. Recommended Pure Grass Seeding Rates

Pure Stand of	Seeding Rate kg/ha
Reed Canary	9
Brome	11
Timothy	9
Orchard	9

TIMOTHY

Timothy is the most widely used forage grass in Ontario. It grows under a wider range of environments than any other grass used, and is easy to establish and maintain. Alfalfa-timothy mixtures are among the most popular and productive mixtures for stored feed. Timothy is well adapted to the heavier soil types and variably drained fields. Cut for hay at the heading stage, timothy is a high-yielding quality grass. Like all grasses, in a mixture it contains about half the crude protein of alfalfa. For pasture or hay aftermath, timothy is a lower producer than orchard or brome. Palatable and high-yielding in the spring, it grows back slowly after cutting or grazing, and most varieties produce relatively poor growth during the dry midsummer. However, since timothy adds stand insurance, small to moderate amounts are useful when making new seedings with legume.

BROMEGRASS

This grass species is important for early and late cut hay. When harvested at the recommended "heads emerged" stage, it is higher in digestibility and much earlier maturing than timothy. As bromegrass advances in maturity, its digestibility decreases at a slower rate than other grasses. Bromegrass produces slightly more aftermath than timothy and combines well with alfalfa in legume-grass mixtures.

For early pasture bromegrass is excellent. Used in mixtures it permits early grazing in the spring and produces good growth in the fall. Use only recommended varieties. Seeding must be shallow, no deeper than 1 - 2 cm.

ORCHARD GRASS

This grass is an early maturing forage that grows rapidly under a high nitrogen fertilization program. It is cut for stored feed when the heads are just emerging from the boot. All varieties are adapted to silage and pasture mixtures. The later varieties will combine better with alfalfa for hay or hay- pasture mixtures.

Orchard grass grows back rapidly after cutting or grazing. It is our best grass for aftermath production during the hot, drier summer period. It will reduce the bloating effect of alfalfa and the clovers when grown in mixtures. For pasture, the maturing stems and heads should be clipped in late May or in early June to maintain leafy, palatable growth.

Table 21. Recommended Grass Varieties

Variety	Heading Date (Guelph)	Heading Date (Kapuskasing)	Aftermath Production	Tolerance to Variable Drainage	Distributor[1]
Timothy					
Salvo	June 16	June 22	Good	Good	SeCan member
Toro	June 20	July 3	Good	Good	Oseco Inc.
Basho	June 22	July 2	Good	Good	Public
Richmond	June 22	July 2	Fair	Good	Mapleseed Inc., Otto Pick & Sons Seeds
Champ	June 23	July 1	Good	Good	Public
Itasca	June 25	July 3	Fair	Good	UCO
Mariposa	June 24	July 2	Good	Good	UCO
Timfor	June 28	July 3	Fair	Good	Northrup King Seeds
Climax	June 28	July 5	Fair	Good	Public
Pronto	July 1	July 3	Fair	Good	King Agro Inc.
Bromegrass					
Baylor	June 10	June 26	Good	Fair	Oseco Inc.
Beacon	June 10	June 25	Good	Fair	Oseco Inc., UCO
Blair	June 10	June 24	Good	Fair	Mapleseed Inc.
Bravo	June 10	June 25	Good	Fair	Otto Pick & Sons Seeds
Saratoga	June 10	June 24	Good	Fair	Public
Tempo	June 10	June 24	Good	Fair	Otto Pick & Sons Seeds
Orchard Grass					
Hallmark	June 2	June 15	Excellent	Poor	UCO
Juno	June 2	June 15	Excellent	Poor	Mapleseed Inc., Otto Pick and Sons Seeds
Ina	June 8	June 15	Excellent	Poor	Otto Pick & Sons Seeds
Napier	June 8	June 16	Excellent	Poor	Oseco Inc.
Sumas	June 12	June 18	Excellent	Poor	Oseco Inc.
Kay	June 12	June 18	Excellent	Poor	Oseco Inc.
Reed Canary Grass					
Frontier	June 10	June 24	Excellent	Excellent	Public
Vantage	June 10	June 24	Excellent	Excellent	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*

Orchard grass requires well-drained soils to perform adequately. Surface drainage is necessary as ice conditions or flooding will kill orchard grass.

REED CANARY GRASS

This grass species tolerates excessive moisture and is highly productive for long-term hay or pasture on poorly drained soils, or areas subject to prolonged periods of flooding. It is also adapted to dry upland soils. Reed canary grass is less palatable than other grasses and, if allowed to mature, is tall and coarse. When grazed heavily enough to prevent heading, reed canary grass is a good pasture producer.

For stored feed reed canary grass is more acceptable to livestock when stored as silage or haylage, rather than dry hay, due to its coarse growth habit.

CREEPING RED FESCUE

Creeping red fescue establishes well on a wide range of soil types and will establish plants also on well-fertilized subsoil. It spreads vigorously on ditch banks with a solid underground root system. Such roots hold the soil from underneath while the thick, fine, leafy top growth protects the soil surface against water movement. These characteristics, plus its low growth, make it very useful for stabilizing soils on ditch and creek banks and on grass waterways. Creeping red fescue survives well in long term pastures.

TALL FESCUE

Tall fescue is a coarse leafy grass useful in long-term pasture and in erosion control. It is adapted to most soil types, tolerant of imperfect drainage, and withstands animal traffic well. Recently, a seed-borne systemic fungus (an endophyte) has been linked to poor animal performance on tall fescue pasture. Endophyte-free seed is available and should be sown when tall fescue is seeded for pasture. Once introduced by infected seed, the fungus cannot be controlled in an established stand of tall fescue.

MEADOW FOXTAIL

Meadow foxtail is a long-lived perennial grass which resembles timothy in appearance and is well adapted to intensive pasture management. It performs well on poorly drained soils, has very early spring growth, and responds well to nitrogen. Mid-summer production during periods of high temperature and drought may be low. Seed is light, fluffy and hairy, and therefore, should be coated prior to seeding. Only common seed is available at the present time.

ANNUAL RYEGRASS

Ryegrass is a rapidly growing bunch grass that is adapted to a wide range of soil conditions. It is a useful species for mid to late season production and is very responsive to nitrogen fertilization. Two types of annual ryegrass are available and they differ remarkably in their growth habit. The Italian ryegrasses are actually short lived perennials. However, under Ontario winter conditions, there is usually 100% winterkill. When grown as an annual, the Italian ryegrasses remain vegetative, producing a lush leafy growth that usually doesn't grow taller than 40 cm. It is an ideal pasture species and can be grazed as often as five or six times. The Westerwold type is a true annual. It will produce a variable number of seed bearing tillers depending on the variety. The Westerwolds varieties grow to 40-80 cm high making them suitable for pastures or hay crops. Feed quality decreases rapidly after heading. The dry matter content varies from 10-20% depending in the variety, maturity and season.

THE BLUEGRASSES

Two common bluegrasses in Ontario, Canada and Kentucky, grow on about one million hectares of permanent pasture land. Much of this pasture is low in production but can be improved by renovation, fertilization and weed control. The dense but shallow rooted bluegrasses produce lush, palatable growth during the springtime but low yields during the dry, hot midsummer in southern Ontario.

Properly fertilized and managed, their production can be markedly improved, especially in the cooler climate of northern Ontario. In pastures, they serve as a bottom grass that controls weed invasion, withstands close grazing and tramping, and creeps and fills in where other species thin out.

Table 22. Timothy Variety Yields

Variety	Yield (as % of Climax) Southern Ontario	Northern Ontario
	%	%
Climax	100	100
Basho	99	103
Champ	98	108
Itasca	101	104
Mariposa	102	103
Pronto	97	101
Richmond	98	102
Salvo	98	98
Timfor	101	105
Toro	98	100

Average yield of Climax, southern Ontario trials 9.6 t/ha; in northern Ontario trials 6.9 t/ha.

Table 23. Orchard Grass Variety Yields

Variety	Yield (as % of Hallmark) Southern Ontario	Northern Ontario
	%	%
Hallmark	100	100
Ina	100	97
Juno	100	99
Kay	103	104
Napier	102	95
Sumas	104	102

Average yield of Hallmark, southern Ontario trials 10.2 t/ha; in northern Ontario trials 6.1 t/ha.

Table 24. Bromegrass Variety Yields

Variety	Yield (as % of Baylor) Southern Ontario	Northern Ontario
	%	%
Baylor	100	100
Beacon	101	104
Blair	99	—
Bravo	98	—
Saratoga	98	94
Tempo	96	103

Average yield of Baylor, southern Ontario trials 10.7 t/ha; in northern Ontario trials 8.6 t/ha.

Table 25. Reed Canary Grass Variety Yields

Variety	Yield (as % of Frontier) Southern Ontario	Northern Ontario
	%	%
Frontier	100	100
Vantage	102	98

Average yield of Climax, southern Ontario trials 11.4 t/ha; in northern Ontario trials 8.4 t/ha.

ANNUAL CROPS FOR FORAGE IN SOUTHERN ONTARIO

SPRING PASTURE

Autumn-seeded fall rye or **winter triticale** can be grazed for a short period in the spring, preferably after the stems start to form. Seed fall rye at 150 kg/ha, and winter triticale at 100-125 kg/ha. Keep stock off when wet. Another pasture or green chop crop (e.g. corn or sorghums) may follow the rye for summer feed in intensive programs.

SUMMER GREEN CHOP OR PASTURE

Sudan Grass Hybrids, Sorghum Hybrids, Sorghum-Sudan Hybrids Seed from mid May to early June at about 14 kg/ha in 18 or 36 cm drill rows. The crop is ready for green chop or grazing by late July-August. Do not graze before 75 cm high or during severe stress as **prussic acid poisoning** could occur. If frozen, allow three days following frost before grazing again to avoid prussic acid poisoning. Aftermath yields are moderate but high if warm moist weather prevails. Under good nitrogen fertility, these crops can produce large quantities of nutritious , palatable herbage. They are particularly useful on dairy farms to supplement normal pastures during August and September. These hybrids are not recommended in short season areas because of inconsistent yields and danger of prussic acid poisoning.

Cereals Seed any time in the season to produce pasture in six to eight weeks. Seed at 100 kg/ha. Graze when stems are forming. No aftermath can be expected.

AUTUMN PASTURE

Oats Seeded at 100 kg/ha between mid July and mid August, ready for grazing in six weeks.

Fodder rape Seed in early July at 1.7 kg/ha in 71 cm rows. May be seeded in solid stands, but yields are 25% lower. Pasture in late October. Makes good hog, sheep, or beef pasture. Taints milk.

Marrowstem kale Seed by early June on clean fields well supplied with nitrogen (85 kg/ha). Solid seedings at 7 kg/ha give good yields for grazing in August and September; 71 cm row seedings for grazing in October and November. Kale is palatable to all classes of livestock. Moderate intakes will not produce off-favors in milk. The varieties **Maris Kestrel** and **Gruner Angiliter** are recommended.

Fall rye or **Winter Triticale** Either species gives good fall pasture by October 1. Seed rye at 150 kg/ha and triticale at 120 kg/ha.

SILAGE CROPS

Corn is the most productive silage crop. Any of the cereals make satisfactory silage harvested by the early dough stage. The sudan grass, sorghum and sorghum-sudan hybrids can also be made into silage.

FORAGES FOR SOIL CONSERVATION

Most of the grass and the legume species used for livestock forages can be used for erosion control and soil conservation purposes to stabilize soil, to prevent weed infestation and to provide an attractive appearance. When selecting species or mixture consider the factors of permanence, adaptability to the particular location, moisture, soil characteristics, use of the area, frequency of mowing. Grasses with creeping root systems (rhizomous) are preferred to bunch grasses. Legumes contribute nitrogen. Recommended species and mixtures are given in Table 24.

Table 26. Special Pupose Mixtures for Livestock

Use	Components	Seeding Rate kg per hectare	Comments
Horse pasture	Alfalfa	9	Early spring seeding is preferred.
	White clover	2	
	Timothy	5	
	Bromegrass	9	
	Kentucky bluegrass	5	
Horse paddock Dairy Holding Area	Tall Fescue	14	Early spring seeding is preferred. For exercise area only. Clip if necessary.

Table 27. Mixtures for Soil Conservation

Use	Components	Seeding Rate kg per hectare	Comments
Ditch banks	Trefoil (Empire Type)	13	Early spring seeding is preferred.
	Creeping Red Fescue	20	Apply 2 cm of straw as a mulch.
	Tall Fescue	45	Best results are obtained by seeding immediately after digging or reshaping. Late summer or early fall seedings are preferred. Mulch spring and early summer seedings with 2 cm straw to prevent drying out.
Waterways	Any of the Alfalfa or Trefoil based mixtures (Tables 12 and 15)		These mixtures can be used and harvested for stored-feed where standing water is not a problem and the slope not too severe. Otherwise the Trefoil-Fescue mixture or Tall Fescue should be used.
	Tall Fescue	22	Tall fescue is a tough sod forming grass which can withstand wear by livestock and farm machinery. It is recommended for erosion control on diversion terraces, grass waterways, and farm pond dams.

FERTILIZERS FOR FORAGE CROPS

Soil Testing

Fertilizer requirements for forages in Ontario can best be estimated by using a soil test along with information on the species grown and past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (crops such as hay, corn silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under those conditions.

Plant Analysis

Plant analysis is a useful supplement to soil testing for evaluation of fertilizer requirements and for diagnosing nutrient deficiencies of forage crops. It is quite independent of soil testing and for phosphorus, potassium, magnesium and manganese it is a very useful "second opinion". For nitrogen and zinc it has not been very reliable. For boron and copper we do not have a reliable soil test so plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately.

For forage legumes sample each species separately. The plant cut at normal mowing height at the late bud stage is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at the late bud stages.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

Table 28. Interpretation of Plant Analysis for Alfalfa[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen	%	—	5.5
Phosphorus	%	0.20	0.5
Potassium	%	1.7	3.5
Calcium	%	—	4.0
Magnesium	%	0.20	1.0
Sulphur	%	0.22	—
Boron	ppm (ug/g)	20	90
Copper	ppm	5	30
Manganese	ppm	20	100
Molybdenum	ppm	0.5	5.0
Zinc	ppm	10	70

[1] *Values apply to the plant cut at normal mowing height at the late bud stage.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations are therefore based on the crop and adjusted downward if manure is applied (see *Manure* section in *Soils*). Stands containing half or more legume do not require nitrogen fertilizers.

Grass stands containing less than one-third legume require large amounts of nitrogen. Where conditions permit, therefore, it is generally more profitable to reseed to mixtures containing legumes. It can be profitable, however, to fertilize grass stands consisting of productive species such as brome, orchard, or timothy. The use of nitrogen will also increase the protein level in the grass. The rates of nitrogen recommended for grass stands have been developed on the basis of the price of nitrogen relative to the value of hay (see Table 30). The first application for hay or pasture should be made as early as possible in the spring, followed by a second application after the first cutting and a third application after the second cutting. To avoid the danger of nitrate toxicity no more than 170 kg of N per ha should be applied at any one time.

Table 29. General Nitrogen Requirements-Perennial Forages

Crops	N Required kg/ha[1]
Legume or legume-grass at seeding - with or without companion crop	15
Unimproved pasture	50
Grass for seed	90
Hay or pasture - 1/2 or more legume	0
Hay or pasture - 1/3 to 1/2 legume	60
Hay or pasture - grass (less than 1/3 legume)	(See Table 30)

[1] *100 Kg/ha = 90 lb/ac.*

Table 30. Nitrogen Requirement Table for Improved Grass Hay or Pasture

Value of Grass		Application	Cost of Nitrogen Fertilizer - ¢/kg (¢/lb)			
Hay @ 15% Moisture		**No.[2]**	**60 (27.2)**	**70 (31.7)**	**80 (36.3)**	**90 (40.8)**
$/tonne	**($/ton)**		**Nitrogen Requirement[1] (kg/N/ha)**			
30.00	(27.22)	1	95	75	69	45
		2	75	60	50	35
		3	60	50	40	30
50.00	(45.36)	1	130	125	115	105
		2	105	100	90	80
		3	85	80	70	65
70.00	(63.50)	1	150	140	135	130
		2	120	115	110	100
		3	95	90	85	80

10 tonne = 11 ton, 100 kg/ha = 90 lb/ac.

[1] *All rates should be reduced by one third where the crop is to be harvested by grazing because of recycling through manure and urine. Where manure is applied to machine harvested forage, reduce the fertilizer application according to the amount and quality of manure (see Manure section in Soils).*

[2] *1. First application to be made prior to May 10.*
2. Second application to be made after the first cut.
3. Third application to be made after the second cut only if there is reasonable assurance of a third cut.

Phosphate and Potash

Phosphate and potash requirements for forages are presented in Tables 31 and 32. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Where a soil test is not available, a rough estimate of requirements can be obtained from Tables 31 and 32 using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Tables 31 and 32).

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating (see Tables 31 and 32).

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

When direct seeding on soils which require phosphate fertilizer, establishment may be improved by the placement of a high phosphate fertilizer 5 cm directly below the seed. Using a grain drill with fertilizer and grass seed attachments, this placement may be accomplished by drilling tthe fertilizer through the furrow opener and dropping the forage seed on a firm soil surface directly behind the furrow opener. Usually it is advisable to firm the soil surface immediately after seeding.

The timing of fertilizer application to established forage stands may influence the response obtained. Potassium, where required, is best applied after the last harvest prior to the fall rest period (see *Fall Management*). Phosphorus, if required may be applied with the potassium in the fall or applied separately in the spring or summer.

Table 31. Phosphate Requirements for Forages Based on OMAF Soil Tests

	At seeding with or without nurse crop		Forages at seeding-band seeded[1]		Established hay or pasture		Unimproved pasture	
Phosphorus Soil test	**Rating**	**Phosphate (P_2O_5)[2] Required kg/ha**	**Rating**	**Phosphate (P_2O_5)[2] Required kg/ha**	**Rating**	**Phosphate (P_2O_5)[2] Required kg/ha**	**Rating**	**Phosphate (P_2O_5)[2] Required kg/ha**
0-3		130		130		90		70
4-5		110		110		70		60
6-7	LOW	90	LOW	90	LOW	60	LOW	50
8-9		70		70		50		30
10-12		50		50	MEDIUM	30		20
13-15		30	MEDIUM	40		20	MEDIUM	20
16-20	MEDIUM	20		30		0		0
21-25		20		20	HIGH	0		0
26-30		0	HIGH	20		0	HIGH	0
31-40	HIGH	0		20		0		0
41-50	VERY HIGH	0		20	VERY HIGH	0	VERY HIGH	0
51-60		0	VERY HIGH	0		0		0
61+	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *For use only where seed is banded directly above the drilled fertilizer.*

[2] *Where manure is applied, reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Examples of fertilizer application: An established stand of hay containing over 50% alfalfa would require no nitrogen (see table 29). If it were not manured and the soil tests were 14 phosphorus and 65 for potassium, the phosphate requirement would be 20 kg/ha (from above table) and the potash requirement 70 kg/ha (Table 29). This could be supplied by broadcasting 45 kg/ha (20 ÷ 46 x 100) of 0-46-0 and 120 kg/ha (70 ÷ 60 x 100) of 0-0-60 prior to the fall rest period.*

[3] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 32. Potash Requirements for Forages Based on OMAF Soil Tests

	At Seeding with or without nurse crop		Fall applications for new seeding and established stands			
			Alfalfa[2]		Other Forages	
Potassium Soil Test	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**
0-15		90		480		250
16-30		80		400		220
31-45	LOW	70	LOW	320	LOW	190
46-60		50		250		160
61-80		40		200		120
81-100		30		120		90
101-120	MEDIUM	20		70	MEDIUM	70
121-150		20	MEDIUM	40		40
151-180	HIGH	0	HIGH	0	HIGH	0
181-250	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0
251+	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied, reduce the fertilizer according to the amount and quality of manure (see Manure Section In Soils).*

[2] *Stands of 50% Alfalfa or more. Stands of less than 50% Alfalfa should be fertilized the same as other forages.*

[3] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 251 occur occasionally on clay and clay loam soils, but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Manure

Manure is an excellent source of nutrients and can substitute for manufactured fertilizers. It is an excellent source of nitrogen for grasses but forage legumes do not make efficient use of manure nitrogen. Do not apply manure to perennial forage legumes when there is snow cover because ice frequently forms under the manure and can kill the plants (see *Manure* section in *Soils*).

Liming

Legumes generally are not tolerant of acid soil conditions. Acid soils (pH 6.0 or lower) should be limed one year before seeding, at rates indicated by soil tests.

Micronutrients

The micronutrient boron is particularly important for alfalfa. However, boron fertilizer applications are not required on all soils. Boron deficiency shows up mainly on high pH sandy soils. Boron applications are recommended on all sandy soils and in particular, the sandy loam and loam soils in the area east of the Niagara Escarpment to and including Frontenac County.

A shortage of available boron to the alfalfa plant first affects flowering and reduces seed-set. As the deficiency becomes more serious, the youngest upper leaves of the plant become yellow to red in color in different plants. Growth can be severely stunted and winter hardiness reduced.

Boron deficiency can usually be corrected or prevented by an application of 1.0 to 2.0 kg boron/hectare broadcast annually.

Mixtures of herbicides and fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on boron deficiency and on methods of application see OMAF Factsheet, *Boron Requirements of Alfalfa*, Agdex 121/531.

DISEASE AND INSECT CONTROL IN FORAGE CROPS

(see also Pesticides section)

DISEASES

Verticillium Wilt of alfalfa now occurs in many areas of southern Ontario west of Toronto. Wilt is easily spread from field to field by machinery, on hay, or in manure. For identification of wilt, contact your local crops specialist. Consult Tables and for information on variety resistance to verticillium wilt. See OMAF Factsheet, *Verticillium Wilt of Alfalfa*, Agdex 121/600.

Leafspot diseases, Anthracnose of alfalfa: **Northern Anthracnose** of red clover. Timely harvesting of forage is important to reduce leaf loss and minimize disease in the regrowth. Clean harvest equipment of crop debris before using the equipment in the spring or when moving from field to field.

Phytophtora root rot is a soil-borne disease which can result in root injury or death of alfalfa plants. Young plants in new seedings are particularly prone to damage. The disease shows up in Ontario mainly on poorly drained soils or on clay loam soils during extended periods of wet weather. Consult Table and for information on variety resistance to phytophthora root rot.

Other crown and root rots of alfalfa and red clover. Stresses such as leaf diseases, insects, frequent or untimely harvests, winter conditions and low soil pH increase severity of crown and root rots. Stresses during the growing season render the plants more susceptible to winter stress. Good crop management practices, especially a good harvesting schedule, and maintenance of adequate soil fertility and proper pH help to reduce disease severity. Control leafhoppers in alfalfa. Avoid mechanical injury of the crowns as much as possible. Crowns are easily injured by machinery and by livestock tramping, especially when the soil is wet.

INSECTS

Alfalfa Weevil Fungal disease and several species of parasites which help control the weevil are now established throughout Ontario and in most years forage stands do not warrant treatment with insecticides. However sporadic outbreaks still occur and farmers should check their fields carefully each year to detect threatening infestations. For more information on the alfalfa weevil, see OMAF Factsheet, *Alfalfa Weevil* Agdex 121/622. For early detection of damaging populations, see OMAF Factsheet, *Early Warning System for Alfalfa Weevil Management*, Agdex 121/622.

The larvae cause most of the damage. They hatch from eggs deposited in the stems and crawl to the tops of alfalfa where they feed on the developing leaf and flower buds. In heavy infestations, they shred the leaves so badly that fields take on a grayish-white or frosted appearance. Experience in Ontario has shown that the peak of larval attack coincides with the bud stage of the first crop. When threatening infestations occur, fields should be cut immediately to eliminate feeding damage. The bud stage is also the best time to cut the crop for maximum yield of protein.

The key to weevil control is proper timing of harvest and treatment based on field inspection. Examine each field twice a week from mid May to June. Check several areas throughout the field. Look for damage to show up first on shallow soils or on southerly slopes.

1. **First Cut** If 25% of the stems have feeding damage in the tips, cut and remove from fields as soon as possible. If it is not possible to cut the crop immediately, treat with an insecticide as recommended in the following table.
2. **Second Cut** If damage was serious on first cut, feeding may continue and early regrowth should be carefully checked. If feeding retards regrowth, apply an insecticide.

Table 33. Alfalfa Weevil Control

Insecticide	Insecticide Formulation[1]	Product per ha	Days to Cutting or Grazing
Furadan *	480F	285mL	7
Imidan	50 WP	2.2 kg	7
Malathion[2]	500 EC	2-2.75L	7
Methoxychlor	240EC	5.5L	7
	50 WP	2.2 kg	

* *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

[1] *EC (Emulsifiable Concentrate); F (Flowable); WP (Wettable Powder).*

[2] *Less effective below 16°C*

CAUTION: See the warning PROTECT HONEYBEES in *Disease & Insect Control* in the Corn section. When planning to apply a pesticide, advise local beekeepers so that they have an opportunity to move colonies out of the danger area. Your local agricultural representative has a listing of the beekeepers in your area.

Alfalfa Blotch Leafminer This pest of alfalfa is now present throughout Ontario. The adult leafminer is a small fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots feed inside the leaflet eating away the center part and producing mines or tunnels that terminate in blotches.

Damage to alfalfa leaves can be extensive and can result in nutritional loss and/or leaf drop. There are three generations of flies about 30 days apart. Cutting generally controls the first generation except on new seedings where an insecticide may be needed. Subsequent generations usually do not correspond to cutting dates. Insecticides effectively control this insect if applied in the "pinhole" stages in late May, early July and mid August. For early detection of damaging infestations, see Canadex Leaflet, *Early Warning System for Alfalfa Blotch Leafminer Management in Ontario*, Agdex 121/622.

Table 34. Alfalfa Blotch Leafminer Control

Insecticide	Formulation[1]	Product per ha	Minimum Days to Cutting or Grazing
Cygon	480E	550 mL	2
*Furadan	480 F	550 mL	7
Imidan	50 WP	2.2 kg	7
Methoxychlor	240 EC	5.5 L	7
	50 WP	2.2 kg	

[1] *E or EC (Emulsifiable Concentrate); F (Flowable); WP (Wettable Powder).*

* *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

Potato Leafhopper The potato leafhopper causes a substantial loss in alfalfa yield and quality some years, particularly during dry seasons when plants are under stress. Damage to direct seedings may be severe. The first cut of established fields escapes injury but as leafhoppers become more prevalent in late June to mid August, damage may be severe.

The potato leafhopper is a light green, wedge-shaped insect about 0.3 cm long when fully grown. The immature or nymph stage is yellowish-green and wingless but otherwise resembles the adult. Adult leafhoppers may jump or fly. Nymphs walk sideways or backwards to hide on the underside of the leaves.

This insect feeds by sucking plant juices. The alfalfa is stunted and the leaves turn yellow to bronze in color. A discolored V-shaped or triangular area often develops on the tips of leaflets. While this marking is characteristic of leafhopper presence, the leaf discoloration may also be a disease symptom or nutritional deficiency.

Effective control of the potato leafhopper depends on recognizing the adults and nymphs before symptoms become apparent. Check alfalfa fields frequently beginning in late June. See OMAF Factsheet, *Potato Leafhopper in Alfalfa*, Agdex 121/622. When leafhoppers are found, spray with one of the following.

Table 35. Leafhopper Control

Insecticide	Formulation[1]	Product per ha	Days to harvest
Cygon	480 E	425 mL	2
Methoxychlor	240 EC	5.5 L	7
	50 WP	2.2 kg	7

[1] *E or EC (Emulsifiable Concentrate); WP (Wettable Powder).*

Armyworm Maintain a close watch for outbreaks in grasses in late June and July. If they become destructive, control them as indicated in **Disese and Insect Control** in Cereal Crops section.

Cereal Leaf Beetle Refer to quarantine regulations under Insects, Cereal Crops section, concerning movement of hay.

European Skipper This is an occasional but important pest of timothy, both in hay and seed production. The adult is an orange butterfly with a 2.5 cm wing spread. It congregates in damp places and skips about hay fields in mid summer. The larvae are light green caterpillars up to 2.5 cm long, usually found within rolled leaves where they feed. Leaf margins become irregularly notched and when abundant they defoliate timothy. Fields must be checked for the caterpillars by late April or early May. Initially, the small caterpillars have black heads but soon become a brown color with two light bands. If six caterpillars in an area 30 cm x 30 cm are found as early as the brown-headed stage, treat the field or the infested area. Use either Thuricide HPC** at 2.25 L/ha or Dipel at 0.3-0.6 kg/ha. Note that these insecticides will not immediately kill the caterpillars. However, they will stop feeding.

Grasshoppers If grasshoppers become destructive, control them by spraying with an insecticide listed in Table 58 in the *Field Peas & Field Beans* Section, or with +Guthion 240SC at 1.4 L/ha.

+*Minimum period before reentry into treated areas is 48 hours.* See Reentry into Treated Areas.

**See "Temporary Registration of Pesticides" inside front cover.

WEED CONTROL IN FORAGES

For weed control recommendations see OMAF Publication 75, *1986 Guide to Chemical Weed Control.*

CEREAL CROPS

CROP MANAGEMENT

Grain crops deserve to be treated as first-rate crops whenever they are included in a cropping program. They must compete for their place in that program by producing high yields economically. To produce high yields requires that all parts of the grain production package be considered. No one factor can support high yields without the others. No one factor can be neglected without a corresponding decrease in yields.

Improved varieties express their full potential only when they are used in combination with proper seeding times, seeding depth, and recommended seeding rates as well as adequate fertility applications. Indeed they perform well only when diseases, insects, and weeds are eliminated as production hazards.

Integrating the production practices into a package becomes the problem of the farmer. On his ability to do this rests the final yield and outcome of his grain production program.

Planting date

Spring Grains

All spring grains respond with higher yields to early seeding. Because cool moist conditions in the spring promote ample tillering and large heads, plant as early as soil conditions permit. The target date should be April 10 for southwestern Ontario, April 15 for central and eastern Ontario and May 10 for Northern Ontario. Planting delays much beyond the target date generally result in a significant yield reduction. **Mingo, Bruce** and **Leger** barley and **Elgin, Donald, Ogle** and **Oxford** oats do not show as great a yield reduction with late planting as do other spring cereal varieties. These varieties should be considered for circumstances where late planning cannot be avoided.

Winter Grains

For good winter survival, seed early enough to obtain adequate top growth and root development in the autumn. For winter wheat grown in areas II and III this is between September 15 - 30 and two weeks later in area I. For winter barley seeding rates should be 1 - 2 weeks earlier than winter wheat.

Planting rate

Seeding rate recommendations are shown in Table 36 and on page 65. The higher range of rates should be used (a) where emergence and early seeding establishment is likely to be poor, e.g. poor seed bed and aerial or broadcast seedings and (b) for late planting where tillering will be reduced.

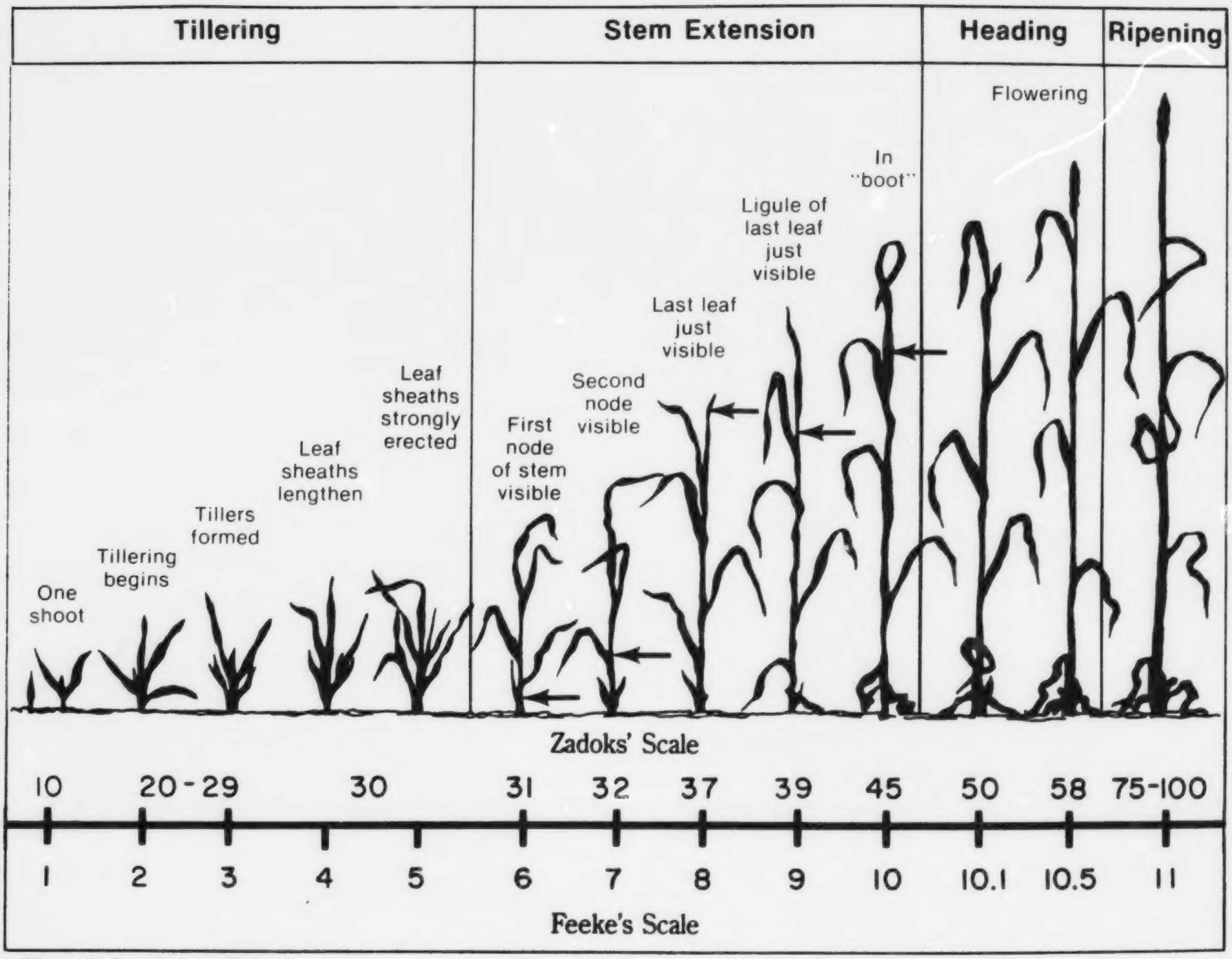

Tillering
Stem Extension
Heading
Ripening
One shoot
Tillering begins
Tillers formed
Leaf sheaths lengthen
Leaf sheaths strongly erected
First node of stem visible
Second node visible
Last leaf just visible
Ligule of last leaf just visible
In "boot"
Flowering
Zadoks' Scale
10
20 - 29
30
31
32
37
39
45
50
58
75-100
1
2
3
4
5
6
7
8
9
10
10.1
10.5
11
Feeke's Scale

Figure 3. Cereal Growth Stages

Table 36. Planting Rates

Crop	Seeding Rate		
	kg/ha	plants/m^2	plants[1]/ metre of row
Barley	80 - 160	200 - 400	35 - 70
Oats	55 - 110	165 - 330	30 - 60
Wheat	100 - 130	240 - 320	45 - 60

[1] *For drills with 18 cm (7 inch) spacing.*

Lodging Control

For fields where lodging is expected a plant growth regulator such as Cerone or Cycocel Extra may be used.

At present Cerone is registered for use on all spring Barley varieties except Birka and Rodeo and all winter wheat varieties. It should be applied at Zadoks' growth stages 37-45 (See Figure 3).

Cycocel Extra is registered on the hard red wheat variety Monopol. It is applied at Zadoks' growth stages 23-31 (See Figure 3).

For information on rates and application procedure, consult the product labels.

VARIETY SELECTION

Variety recommendations are general guides for choosing a variety. Descriptive tables accompanying recommendations show characteristics for each variety which may limit its use. Because no variety is perfect, the recommendations should be coupled with experience and information from the description to choose a variety for your use.

Yield data, presented as tonnes per hectare (t/ha), are included to indicate the relative yield performance of recommended varieties in each of the six testing areas in Ontario. (See Figure 4).

Variety recommendatios for grains to be stored and used as high moisture grains and whole plant silages are the same as those to be used for normal grain storage and use.

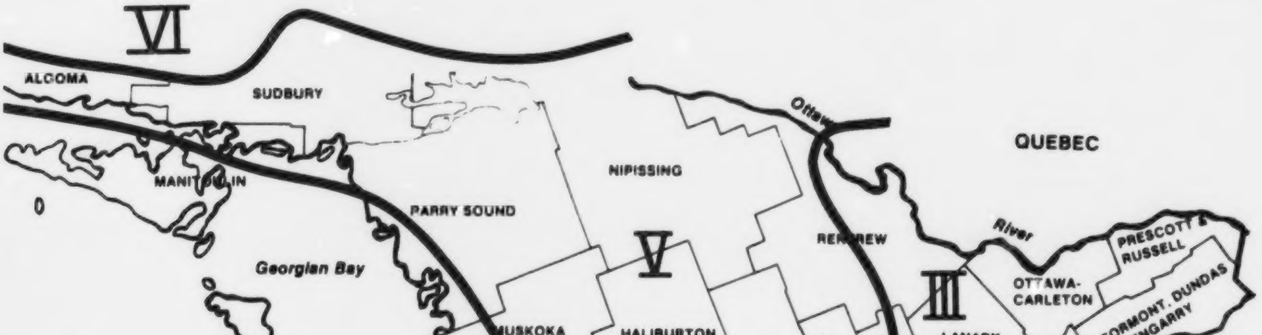

VI
ALGOMA
SUDBURY
MANITOULIN
Georgian Bay
PARRY SOUND
NIPISSING
Ottawa River
QUEBEC
V
RENFREW
III
PRESCOTT & RUSSELL
OTTAWA-CARLETON
STORMONT, DUNDAS & GLENGARRY
LANARK
LEEDS & GRENVILLE
St. Lawrence River
MUSKOKA
HALIBURTON
LENNOX AND ADDINGTON
FRONTENAC
PETERBOROUGH
HASTINGS
VICTORIA
II
Wasaga Beach
GREY
SIMCOE
BRUCE
IV
DUFFERIN
WELLINGTON
YORK
DURHAM
NORTHUMBERLAND
PRINCE EDWARD
Lake Ontario
HURON
PEEL
METROPOLITAN TORONTO
HALTON
PERTH
WATERLOO
HAMILTON WENTWORTH
OXFORD
BRANT
NIAGARA
LAMBTON
MIDDLESEX
HALDIMAND-NORFOLK
ELGIN
I
KENT
Lake Erie
ESSEX
THUNDER BAY
COCHRANE
QUEBEC
RAINY RIVER
L. Superior
ALGOMA
SUDBURY
Sudbury
Timmins
NIPISSING

Figure 4. Cereal Crop Test Areas

SPRING GRAINS

Milling Oats

Milling oats have to meet special quality requirements: plump kernels, high hectoliter weight and groats that are free of discoloration. **Donald, OAC Woodstock** and **Ogle** are preferred for milling purposes.

Mixed Grains

Mixed grains occupy a large hectareage in the province. No specific recommendations regarding the best mixtures can be made. Generally the highest yielding varieties of oats and barley in pure stands also perform best in mixtures.

Height and maturity ratings of the components of a mixture must be matched. For example, in 1985 Donald oats matched well with Leger or Rodeo barley, and Elgin and Ogle oats also matched well with Birka or Leger barley.

An advantage of mixed grains is that leaf and head diseases usually are much less severe than where oats or barley are grown alone.

Spring Wheat

Spring wheat is grown on a small hectarage in Ontario. In areas III, V, and VI, however, it can be competitive with oats and barley as a feed grain. For those farmers who choose to grow spring wheat for feed, the varieties **Glenlea** and **Laval 19** are available.

Glenlea - awnless, white chaff and large red grain. Utility-type wheat not equal in milling quality to hard red spring types.

Laval 19 - awned, white chaff and medium size purple grain. Feed-type with no milling quality.

Spring Triticale

Spring triticale is not generally grown in Ontario as it is later maturing than the other spring cereals. For those farmers who choose to grow spring triticale for feed, the variety **OAC Triwell** is available. It is a rough-awned, white-chaffed variety with good standability and good resistance to powdery mildew and leaf rust. If stands are thin or the crop is stressed around flowering, ergot contamination of the grain can be a problem.

Table 38. Barley Variety Yields[1],[2] Tonne/Hectare

	Test Areas					
Variety	**I (19)[3]**	**II (54)**	**III (15)**	**IV (14)**	**V (11)**	**VI (13)**
Birka	3.6	3.7	4.2	3.7	3.5	4.0
Herta	3.6	3.7	4.1	3.5	3.4	3.9
Rodeo	3.7	3.8	4.2	3.6	3.7	4.2
Bruce	3.4	3.6	3.7	3.3	3.5	4.2
Leger	3.8	3.9	4.4	3.8	4.0	4.6
Mingo	3.5	3.8	4.2	3.5	3.7	3.7
Sophie	3.7	3.6	4.3	3.3	3.5	4.3

[1] *Four-year average (1982-1985)*

[2] *1 t/ha = 893 lb/ac*

[3] *Number of tests*

Table 37. Recommended Barley Varieties

					Reaction to Disease[1]			
Variety	**Area Recommended**	**Type and Maturity**	**Height**	**Lodging Resistance**	**Loose Smut**	**Scald**	**Spot Blotch**	**Mildew**
2-Rowed								
Birka	All areas	Rough-awned late	Short	Very good	MR	MS	S	R
Herta[2]	All areas	Rough-awned late	Medium to short	Medium	MR	MS	S	R
Rodeo	All areas	Rough-awned mideseason	Short	Good	MR	S	S	R
6-Rowed								
Bruce[2]	All areas	Rough-awned early	Medium to short	Medium to good	MS	MS	T	R
Leger	All areas	Smooth-awned midseason	Medium	Medium to good	R	MS	S	MR
Mingo	All areas except VI	Smooth-awned midseason	Medium	Medium	MS	MS	S	MS
Sophie	Areas V and VI	Smooth-awned late	Tall	Medium to poor	MS	MS	S	S

[1] *See Disease and Insect Control in Cereal Crops. R (Resistant); MR (Moderately Resistant); MS (Moderately susceptible); S(Susceptible); T(Tolerant). R indicates resistance to prevalent races only and may not indicate resistance to new races of the disease organism; because of this all varieties should be seed treated with Vitaflow 280 to control loose smut. T indicates that plants become infected but do not suffer significant yield loss.*

[2] *Herta and Bruce may be removed from the recommended list in 1987 because of availability of superior varieties.*

Table 39. Recommended Oat Varieties

Variety	Area Recommended	Seed Size	Height	Lodging Resistance	Maturity	Reaction to Disease[1] Leaf Rust	Barley Yellow Dwarf	Septoria
Donald	All areas	Very large	Medium	Medium	Early to midseason	S	MS	S
Dumont	Areas III, V and VI	Medium to large	Medium	Medium (where recommended)	Late	R	S	S
Elgin[2]	All areas	Large	Short	Good	Early to midseason	S	S	S
OAC Woodstock	All areas	Large	Medium	Medium to good	Midseason to late	R	S	MS
Ogle	All areas	Medium (yellow)	Short	Very good	Early	MS	MR	MR
Oxford	All areas	Medium (yellow)	Medium	Very good	Midseason to late	MS	MS	MR

[1] *See Disease and Insect Control in Cereal Crops. R (Resistant); MR (Moderately Resistant); MS (Moderately susceptible); S(Susceptible)*

[2] *Elgin may be removed from the recommended list in 1987 because of availability of superior varieties.*

Table 40. Oat Variety Yields[1],[2] Tonne/Hectare

Variety	Test Areas I (12)[3]	II (41)	III (8)	IV (10)	V (7)	VI (9)
Donald	3.1	3.8	4.0	4.1	3.3	3.3
Dumont	3.1	3.8	4.3	3.9	3.5	3.6
Elgin	3.1	3.7	3.9	3.7	3.3	3.0
OAC Woodstock	3.0	4.0	4.6	3.9	3.4	3.5
Ogle	3.7	4.0	3.7	4.1	3.7	3.0
Oxford	3.3	3.9	4.1	3.7	3.6	3.2

[1] *Four-year average (1982-1985)*

[2] *1 t/ha = 893 lb/ac*

[3] *Number of tests*

WINTER GRAINS

Winter Wheat

Soft White Winter Wheat. Soft white winter wheat has long been the dominant winter grain of Ontario. Markets are well established, and varieties well adapted to Ontario conditions are available (Table 41). It should be the first choice for farmers wishing to grow a cash crop winter cereal.

Hard Red Winter Wheat. Hard red winter wheat is now grown in Ontario. It cannot yet be recommended because markets are uncertain, and available varieties (predominantly **Monopol**) are being widely tested for quality and adaptability to local conditions. The quality of the hard red winter wheat is very different from that of the traditional soft white varieties. Because of this, the two types should be kept separate throughout the production and marketing channels. Mixed lots will only find a use as livestock feed, and will thus realise a lower price than unmixed lots of white wheat of milling grade.

Table 41. Recommended Soft White Winter Wheat Varieties

Variety	Area Recommended	Lodging Resistance	Height[1] (cm)	Reaction to Disease[2] Leaf Rust	Mildew	Sprouting Resistance
Augusta	I, II, III	Medium to good	100-110	MS	MS	Medium
Frankenmuth	I[3], II[3]	Medium	100-110	S	MR	Medium
Fredrick	I[3]	Medium to good	110-120	MS	MR	Medium to good
Gordon[5]	III[4]	Poor	100-110	S	S	Medium to poor
Harus[6]	I, II	Good	95-100	MS	MR	Medium to good
Houser	I[4], II[4], III[4]	Medium	95-100	S	MR	Poor

Winter Survival: All recommended winter wheat varieties have similar winter survival

[1] *The figures indicate the range generally found in the province*

[2] *See Disease and Insect control in Cereal Crops. MR (moderately resistant) MS (moderately susceptible); S (susceptible)*

All varieties should be seed treated to control loose smut. For futher information see OMAF Factsheet, Winter Wheat in Ontario, Agdex, 122/10.

[3] *Only where test weight is a problem with other varieties.*

[4] *Not on light droughty soils and other locations where low test weight is a problem.*

[5] *Gordon may be removed from the recommended list in 1987.*

[6] *Seed will not be available until 1987.*

Table 42. Soft White Winter Wheat Variety Yields and Test Weights[1]

	Yield[2] (tonne/ha) Test Areas			Test Weight[3] (kg/hL) Test Areas		
Variety	I (18)[4]	II (23)	III (9)	I (19)	II (22)	III (7)
Augusta	4.7	5.1	5.3	74	74	79
Frankenmuth	4.5	4.7	5.0	77	75	79
Fredrick	4.3	4.7	4.6	78	77	82
Gordon	4.3	4.5	5.1	73	71	79
Harus	4.7	5.1	4.8	77	75	81
Houser	4.5	4.9	5.2	73	71	77

[1] *Four year average (1982-85)*
[2] *1 t/ha = 893 lb/ac*
[3] *kg/hL x .801 = lb/bu*
[4] *Number of tests*

Winter Barley Winter barley has higher yield than spring barley but is conderably less winterhardy than winter wheat. It can be expected to survive only in areas south of the 2700 heat unit line. Winter barley matures much earlier than winter wheat and if harvested as a silage crop is suitable for double cropping. For farmers who choose to grow winter barley the varieties **OAC Halton** and **OAC Acton** are available. OAC Halton is a six-rowed, rough awned variety with short straw and good lodging resistance. It is resistant to mildew and leaf rust. OAC Acton is similar to OAC Halton, but has higher yield, better barley yellow dwarf tolerance and improved scald resistance.

Winter Triticale Two feed-type varieties are now licensed: **OAC Wintri** and **OAC Decade.** OAC Wintri has better winter survival compared to the recommended winter wheat varieties. It is very tall, later maturing than Fredrick, and has poor lodging resistance, especially on heavier soils. High levels of nitrogen fertilization can result in lodging problems with yield losses. OAC Decade is much shorter than OAC Wintri and has improved lodging resistance.

Table 43. Distributors for Cereal Grain Varieties

	Variety	Distributor[1]	Breeder
Barley	Birka	W.G. Thompson & Sons Ltd.	Weibull's, Sweden
	Bruce	SeCan Members	OAC Guelph
	Herta	public	Weibull's, Sweden
	Leger	SeCan Members	Ottawa Res. Station
	Mingo	W.G. Thompson & Sons Ltd.	Ciba-Giegy, Ailsa Craig
	Rodeo	W.G. Thompson & Sons Ltd.	Ciba-Giegy, Ailsa Craig
	Sophie	Jean Labonte et Fils Inc.	Univ. of Laval - Ste. Foy, Res. Station
Oats	Donald	SeCan Members	Ottawa Res. Station
	Dumont	SeCan Members	Winnipeg Res. Station
	Elgin	public	OAC Guelph
	OAC Woodstock	SeCan Members	OAC Guelph
	Ogle	public	Univ. of Illinois
	Oxford	W.G. Thompson & Sons Ltd.	OAC Guelph
Spring Triticale	OAC Triwell	Speare Seeds Ltd.	OAC Guelph
Spring Wheat	Glenlea	public	Univ. of Manitoba
	Laval 19	King Argro Inc.	Univ. of Laval
Winter Barley	OAC Halton	SeCan Members	OAC Guelph
	OAC Acton	King Argo Inc.	OAC Guelph
Winter Triticale	OAC Wintri	King Agro Inc.	OAC Guelph
	OAC Decade	King Argo Inc.	OAC Guelph
Winter Wheat	Augusta	W.G. Thompson & Sons Ltd.	Michigan State Univ.
	Frankenmuth	King Argro Inc.	Michigan State Univ.
	Fredrick	public	Ottawa Res. Station
	Gordon	SeCan Members	Ottawa Res. Station
	Harus	SeCan Members	Harrow Res. Station
	Houser	W.G. Thompson & Sons Ltd.	Cornell Univ.

[1] *See Distributor Addresses in General Section*

FERTILIZERS FOR CEREAL CROPS

Soil Testing

Fertilizer requirements for cereals in Ontario can best be estimated by using a soil test along with information on the species grown and past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (with crops such as hay, corn silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under these conditions.

Plant Analysis

Plant analysis is a useful supplement to soil testing for evaluation of fertilizer requirements and for diagnosing nutrient deficiencies of cereals. It is quite independent of soil testing and for phosphorus, potassium, magnesium and manganese it is a very useful "second opinion". For nitrogen and zinc it has not been very reliable. For boron and copper we do not have a reliable soil test so plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies.

Samples for plan analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately.

For cereals the top two leaves at heading are recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. For plants less than 20 cm tall sample the total above ground plant. Expert help will be required to interpret plant analysis results when the samples are not taken at heading.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils.*

Table 44. Interpretation of Plant Analysis for Cereal Crops[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen	%	2.0	2.7
Phosphorus	%	0.1	0.5
Potassium	%	1.0	3.0
Calcium	%	—	1.0
Magnesium	%	0.15	1.0
Boron	ppm (ug/g)	3	40
Copper	ppm	3	50
Manganese	ppm	15	200
Zinc	ppm	10	70

[1] *Values apply to the top two leaves sampled at heading.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for cereal crops (Tables 45 and 46) are, therefore, based on the estimates crop requirements and on the region of the province, and adjusted downward if manure is applied or if the previous crop contained perennial legumes such as alfalfa (see Tables 75 and 73). High rates of nitrogen from manures or manufactured fertilizers can cause lodging of cereals.

Table 45. Nitrogen Requirements - Cereal Crops

Crops	N required[1] kg/ha
Oats, buckwheat, millet, spring rye (southern Ontario)	35
Oats, buckwheat, millet, spring rye (northern Ontario)[2]	55
Barley, mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (southern Ontario)	45
Barley, mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (northern Ontario)[2]	70
Cereals seeded as a nurse crop for forages	15
Winter Triticale	80[3],[4]
Winter barley, winter rye	90[3],[4]

100 kg/ha = 90 lb/ac

[1] *Where manure is applied or the preceding crop is a legume sod, reduce the nitrogen rates as shown in Tables* 75 *and* 73.

[2] *Northern Ontario refers to Algoma, Cochrane, Kenora, Manitoulin, Nipissing, Rainy River, Sudbury, Temiskaming and Thunder Bay districts.*

[3] *0 to 10 kg nitrogen per hectare at seeding and 90 to 80 kg nitrogen per hectare in early spring.*

[4] *When not in rotation with tobacco.*

Table 46. Nitrogen Requirements for Soft White Winter Wheat[1]

Cost of Nitrogen Fertilizer	Expected Yield[2] - t/ha		
	3.5	4.5	5.5
$/kg	Most Profitable Nitrogen Application[4,5] - kg/ha		
.60	80	90	110
.70	75	85[3]	110
.80	70	85	105

100 kg/ha = 90 lb./ac

[1] *Nitrogen requirements are based on winter wheat valued at $160/tonne.*

[2] *Expected yield is that yield which you, in your experience, should obtain under your conditions of soil, climate and management.*

[3] *If your expected yield is 4.5 t/ha and nitrogen costs $.70/kg, then 85 kg/ha of nitrogen is the most profitable rate of application.*

[4] *0 to 10 kg/ha of nitrogen at seeding, and the remainder in early spring.*

[5] *When not in rotation with tobacco.*

Phosphate and Potash

Phosphate and potash requirements for cereals are presented in Tables 47 and 48. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Where a soil test is not available, a rough estimate of requirements can be obtained from Tables 47 and 48 using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for a MEDIUM soil test rating (see Tables 47 and 48).

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating (see Tables 47 and 48).

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Table 47. Phosphate Requirements for Cereals Based on OMAF Soil Tests

	Spring barley and mixed grain		Oats, spring wheat, spring triticale, spring rye, fodder rape, canola, kale, flax, and buckwheat		Winter wheat, W. rye, W. barley, W. triticale		Winter or spring grains seeded down	
Phosphorus Soil Test	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha	Rating	Phosphate (P_2O_5)[1] Required kg/ha
0 - 3		110		70		70		130
4 - 5		100		60		60		110
6 - 7	LOW	90	LOW	50	LOW	50	LOW	90
8 - 9		70		30		30		70
10 - 12		50		20		20		50
13 - 15	MEDIUM	20	MEDIUM	20	MEDIUM	20	MEDIUM	30
16 - 20		20		0		20		20
21 - 25		0	HIGH	0		0		20
26 - 30	HIGH	0		0	HIGH	0		0
31 - 40		0		0		0	HIGH	0
41 - 50	VERY HIGH	0	VERY HIGH	0		0		0
51 - 60		0		0	VERY HIGH	0	VERY HIGH	0
61+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils). For spring barley in southern Ontario not manured and not following a legume sod, the nitrogen requirement is 45 kg/ha (see Table 45). If the soil tests are 11 for phosphorus and 48 for potassium the phosphate requirement would be 50 kg/ha and the potash requirement 50 kg/ha. These nutrients could be supplied by drilling 250 kg (50 ÷ 20 x 100) of 5-20-20 per hectare to supply the phosphate and potash and broadcasting 100 kg of 34-0-0 or 75 kg of 45-0-0 per hectare to supply the recommended amount of nitrogen.*

[2] *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 48. Potash Requirements for Cereals Based on OMAF Soil Tests

	Spring barley and mixed grain		Oats, spring wheat, spring triticale, spring rye, fodder rape, kale, flax, buckwheat		Winter wheat, W. rye, W. barley, W. triticale with or without seeding down		Spring cereals seeded down	
Potassium Soil Test	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**	**Rating**	**Potash (K_2O)[1] Required kg/ha**
0 - 15		90		70		50		90
16 - 30		80		50		40		80
31 - 45	LOW	70	LOW	40	LOW	30	LOW	70
46 - 60		50		30		20		50
61 - 80		40	MEDIUM	20		20		40
81 - 100		30		20	MEDIUM	20		30
101 - 120	MEDIUM	20	HIGH	0	HIGH	0	MEDIUM	20
121 - 150		20		0		0		20
151 - 180	HIGH	0		0		0	HIGH	0
181 - 210		0	VERY HIGH	0	VERY HIGH	0		0
211 - 250	VERY HIGH	0		0		0	VERY HIGH	0
251+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quantity of manure (see Manure Section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 250 occur occasionally on clay and clay loam soils but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

DISEASE AND INSECT CONTROL IN CEREAL CROPS

(see also Pesticides section)

Seed Treatment

Following cleaning, all cereal should be treated with a seed treatment. Good coverage of the seed is essential. Follow the precautions under *Seed Treatments in General Information on Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments control certain soil and seed-borne cereal diseases. The recommended seed treatments and diseases controlled are given in Table 49.

DISEASES

See OMAF Factsheets, *Leaf and Head Diseases of Barley*, *Agdex 114/632; Leaf Diseases of Winter Wheat*, Agdex 112/600; *Head Diseases of Winter Wheat*, Agdex 112/630; *Smut Diseases of Grain Crops*, Publication 524. *Root, crown and basal stem diseases of winter wheat*, Agdex 112/630.

Diseases Affecting Wheat, Barley and Oats.

Powdery mildew is favored by warm, humid weather. White powdery growth of the mildew fungus appears on the foliage and sometimes on the heads. Wheat, barley and oats are each attacked by different strains of the fungus. In areas prone to severe mildew, use the more resistant cultivars of winter wheat (Table 41) or resistant cultivars of barley (Table 37).

Ergot occurs from time to time on barley and triticale. Exercise caution in feeding grain containing the black ergot bodies to livestock, especially swine. Do not sow seed containing ergot. Consult Agriculture Canada Publication 1438, *Ergot of Grains and Grasses*.

Barley Yellow Dwarf or Oat Red Leaf. This disease was unusually severe in 1959 and 1976. It is unlikely to be severe unless warm weather and southerly winds occur in April Direct control by spraying the aphids which carry the virus is unlikely to be useful. Early seeding is an advantage in spring grains. Winter wheat also is susceptible to barley yellow dwarf. Late planting helps to avoid infection in the fall. See OMAF Factsheet, *Cereal Virus Diseases*, Agdex 110/632.

Wheat Diseases

Loose Smut. Sow pedigreed seed. Vitaflow-280 which contains carbathiin for smut control and thiram for control of seedling blight is recommended for wheat grown for food or feed. All wheat grown for seed should be treated with Vitaflow-250 or the higher rate of Vitaflow-280 for effective smut control.

Spot Blotch, Seedling Blight, Root Rot and Head Blight are often serious and widespread and are caused by the same fungus. The fungus overwinters in seed, barley debris and soil. All barley seed should be treated with the fungicide Vitaflo-280 to control the fungus inside the seed and that which invades seedlings from the soil. To reduce severity of spot blotch and head blight, avoid growing barley after barley, wheat and grasses. Early planting helps to avoid serious disease in July. Disease is less severe on barley grown in mixtures with oats. Bruce barley shows some disease resistance.

Net Blotch and Scald occur especially in cool, humid seasons. Two-rowed barley usually are more susceptible to net blotch and scald than are 6-rowed barleys. To help prevent buildup of these diseases, avoid growing barley after barley, plow down stubble and straw as completely as possible, and treat seed with a fungicide containing carbathiin or maneb (Table 49).

Table 49. Cereal Seed Treatments

Product	Active Ingredient	Formulation[2]	Oats - covered smut	- loose smut	Barley - covered smut	- loose smut	- seedling blight	Wheat - common bunt	- dwarf bunt	- loose smut	- seedling blight	Rye - seedling blight
Agrox N-M	maneb	P-DB	+	+	+	—	—	+	—	—	+	+
Agrox flowable	maneb	S	+	+	+	—	—	+	—	—	+	+
Busan 30	TCMTB	EC	+	+	+	—	—	+	—	—	+	+
Co-op N-M	maneb	P-DB	+	+	+	—	—	+	—	—	+	+
Polyram Liquid	metiram	S	+	+	+	—	—	+	—	—	+	+
Polyram 7	metiram	P-DB	+	+	+	—	—	+	—	—	+	+
[1]Vitaflo-250	carbathiin	S	+	+	+	+	+[3]	+	—	+	—	—
[1]Vitaflo-280	carbathiin + thiram	S	+	+	+	+	+	+	—	+	+	+
[1]Vitavax Powder	carbathiin + thiram	P-DB	+	+	+	+	+	+	—	+	+	+
Seed treatments with Insecticides												
Mergamma N-M	maneb + lindane	P-DB	+	+	+	—	—	+	—	—	+	+
Co-op N-M Dual Purpose	maneb + lindane	P-DB	+	+	+	—	—	+	—	—	+	+
[1]Vitaflo Dual Purpose	carbathiin + thiram + lindane	S	+	+	+	+	+	+	—	+	+	+
Vitavax Dual Powder	carbathiin + thiram + lindane	P-DB	+	+	+	+	+	+	—	+	+	+

[1] *Read the paragraph on seed treatments, and also the sections Loose Smut of Barley, Loose Smut of Wheat.*

[2] *EC (Emulsifiable Concentrate); P-DB (Powder Drill Box); S(Flowable Suspension).*

[3] *Reduces seedling blight caused by Spot Blotch, but may not control other seedling blights and seed decay.*

+ *Recommended for disease listed.*

— *NOT recommended.*

Oat Diseases

Septoria Leaf Blotch in oats can cause severe damage in all recommended varieties. The disease is recognized by the appearance of mottled, light and dark brown, elongate blotches on the leaf blade, extending to the leaf sheath and culm. Advanced stages on the culm turn black and the weakened culm breaks over easily resulting in damage due to lodging. Avoid planting oats after oats or mixed grains.

Oat leaf rust is often serious, especially in central and eastern Ontario. European buckthorn is the source of the rust fungus. This shrub is described in O.M.A.F. Publication 49, *Rid Ontario of Common Barberry and European Buckthorn*. Information on resistance of oat varieties to leaf rust is given in Table 39.

Oat Cyst Nematode. Damage by the oat cyst nematode is first noticed about two or three weeks after oat plants emerge, at which time heavily infected plants appear to suddenly stop growing, leaves turn pale in color and begin to die back from the tips downward. These plants fail to tiller resulting in a thin stand of stunted plants which produce little grain. Below ground the root systems are severly stunted and usually discolored, from a pale-yellow in early growth to a yellow-brown in mature plants, as compared to the clear white in healthy plants.

To confirm suspected oat cyst nematode damage, dig up affected plants at early heading stage. Carefully wash soil from the roots by dunking in a pail of water, then examine the roots for presence of young cysts. These appear as tiny, pearl-like objects adhering to the young roots. If still in doubt, send a sample of several plants with adhering soil to the Pest Diagnostic Clinic, Department of Environmental Biology, University of Guelph, Ontario, N1G 2W1 for diagnosis.

If oat cyst nematodes have caused damage do not plant spring grains the following year. Use legume or row crops in the rotation. Corn can be used if the nematode population is low but will suffer damage if the soil is heavily infested. The nematode invades corn roots but does not reproduce in them; thus consecutive cropping to corn effectively reduced the population of oat cyst nematodes.

For additional information, see OMAF Factsheet, *Oat-Cyst Nematode*, Agdex 113/632.

Dwarf bunt occurs primarily in counties bordering Georgian Bay and Lake Huron where snow cover is deep and persistant in late winter and early spring. The bunt fungus survives for many years in the soil and can also be seed-borne. It infects wheat in early spring. None of the registered seed treatments controls dwarf bunt effectively. Rotation of wheat with other crops aids control. Treat seed with a product containing carbathiin to help prevent spread by means of the seed.

Fusarium Head Blight (Scab) outbreaks occur when the weather is warm and wet at the flowering to soft-dough stages. Vomitoxin may be present in diseased heads. See OMAF Factsheets, *Head Diseases of Winter Wheat*, Agdex 112/630 and *Moldy Feeds and Swine Diseases*, Agdex 440/60. Head blight is usually more severe when wheat follows wheat, corn or triticale. Plow down infested stubble and straw.

Eyespot, Strawbreaker and Take All are often damaging especially when wheat follows wheat. Avoid early planting. Clean plowing helps to reduce eyespot severity. Include crops such as soybeans, field beans, canola, clovers, alfalfa or oats in the rotation.

Septoria leaf spot is most severe at the heading stage but also develops under snow cover. Speckled brown spots develop on the leaves. A related disease develops on the heads as purplish-brown areas. Wet, windy weather and warm temperatures are favorable to disease development. Rotation with crops other than cereals and plowing down of cereal residues help to control leaf spot.

Leaf rust is often widespread, especially after wheat heads emerge. The rust fungus appears to overwinter on winter wheat and may also be blown from the U.S.A. Information on resistance of wheat varieties to leaf rust is given in Table 41.

Stem rust may be serious in wheat grown near common barberry. The common barberry is the source of the rust fungus and should be destroyed. Contact your Area Weed Inspector or Ministry of Agriculture and Food office for assistance in identification and control. Consult OMAF Publication 49, *Rid Ontario of Common Barberry and European Buckthorn.*

Snow Mold. In years when snow mold causes great reduction in winter wheat stands, reseed as soon as possible with a spring grain. This disease does not affect spring-planted grain.

Barley Diseases

Loose Smut. Sow pedigreed seed of a resistant barley variety. However, these varieties are resistant ONLY to the prevalent races of smut fungus and may not resist other races. It is **strongly recommended** that **all barley seed be treated with Vitaflow-280** or a drillbox formulation containing carbathiin.

INSECTS

Wireworms damage cereal crops in certain areas every year. Injury is usually most severe in the two years following grass sod. As a precautionary measure, use a drill-box formulation containing lindane (see Table 49). Use a wooden paddle to mix the chemical with the seed. Do not breathe the dust stirred up during mixing, wear rubber gloves and a respirator. Follow the precautions in Precautions with Pesticides section when using seed treatments.

Armyworms are brown to dark green caterpillars with five longitudinal stripes on their bodies. They are 4 cm long when fully grown. They appear in damaging numbers at intervals of about 10 years except for localized infestations which may appear at any time. The caterpillars appear in grain crops during late June to mid July depending upon geographical location. They can best be detected by examining crops frequently during early evening just before sunset; at this time the caterpillars are moving up on the plants to feed. They hide under clumps of grass and clods of dirt during the day. **Five to six larvae in an area 30 by 30 cm warrant chemical control.**

If foliage is heavily notched and most of the caterpillars are less than 4 cm long, treat immediately. When plants are completely defoliated and most caterpillars are fully grown, treatment is not practical. Each field must be assessed and dealt with separately. Armyworms often move in large numbers from one field to another. When this happens it is advisable to spray the border of the invaded field. There is no benefit in applying a control measure when the armyworm is nearly full grown, the pupae present, feeding extensive or the crop near "maturity". By this time most of the damage will have been done.

Malathion is less effective below 16°C. Where less than 60 L of spray are used per hectare. Lannate provides better control than the other insecticides.

Insecticides are listed in order of preference.

Table 50. Armyworm Control

Insecticide	Formulation[1]	Product/ha	Days to Harvest
Dylox	80 SP	700 g	21
	420	1.5 L	
*Lannate	215 L	2.0 L	20
Sevin XLR[2]	480 Su	5.0 L	20
Methoxychlor	240 EC	10.0 L	7

[1] *EC (Emulsifiable Concentrate); SP (Soluble Powder); Su (Suspension); L (Liquid)*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

* *Minimum period before reentry is 24 hours.*

Bee Poisoning

During the past several years spraying for armyworms, especially with Sevin, has resulted in heavy bee kills. **This must be avoided.** Treat only when needed. Use an insecticide other than Sevin if bees are in the area. Avoid contamination of areas where weeds are in bloom. Do not spray when the wind is blowing. Treat in the late evening. If spraying by aircraft, avoid spraying close to roadsides and adjacent fields where plants are in bloom. Advise local beekeepers of your spraying activities. Your local agricultural representative has a list of beekeepers in your area.

Cereal Leaf Beetle is a metallic blue-green beetle 0.5 cm in length, with reddish-orange head and legs. The larva is slug-like in appearance, 0.6 cm in length when mature and yellowish in color, but its true color is obscured by a black deposit of fecal material. Eggs are pinhead in size, elongate and bright-yellow to dull brown in color located along the mid vein on the upper surface of the leaf.

Both the adults and larvae cause damage by chewing long strips of tissue between the leaf veins. However, most of this injury is done by the larvae in June. Heavily damaged fields take on a silvery appearance.

An effective parasite is now established throughout Ontario, which generally controls the cereal leaf beetle. However, treatments may be required in some fields when 2 larvae are found per stem.

Quarantine Regulations. A quarantine is in effect to prevent the spread of this insect to western Canada. Growers contemplating selling baled hay or straw to western Canada should contact the local office of the Food Production and Inspection Branch of Agriculture Canada.

Table 51. Cereal Leaf Beetle Control

Insecticide	Formulation[1]	Product/ha	Days to Harvest
Malathion	500 EC	.55 - 1.1 L	7
Sevin	80 S	1.5 kg	14

[1] *EC (Emulsifiable Concentrate); S (Sprayable)*

Grasshoppers. If they become destructive control them as indicated in the Field Bean section.

Aphids. Aphids are often found on cereals but are seldom numerous enough to cause reduced yields. There must be at least 75 aphids per head, the cereal not near maturity and no heavy rains forecast (which wash off some aphids) before spraying would pay. Immigrant aphids carry yellow dwarf virus. Unfortunately it is not possible to kill the aphids efficiently enough to prevent disease transmission to cereals.

INSECTS IN FARM STORED GRAIN

Insects are a major problem in farm stored grain in Ontario. Ontario producers sustain considerable losses annually. In some instances, shipments to elevators are refused because of insects.

The Key to Control of insects in stored grain is prevention through good sanitation and storage. The following are essential:

1. Clean up all spills of grain and feed. Such spilled material usually becomes infested and is a major source of insect problems. All residue grain that is removed should either be burned, deposited in a sanitary fill or ground up for feed.
2. Bins and equipment must be thoroughly cleaned before storing grain. This means cleaning out all caked material Use a good vacuum cleaner. Such cleaning removes old grain that may be infested with insects that would spread to the new grain. In particular check:

   - corners and cracks
   - behind partitions
   - between double walls
   - outside and under bins
   - grain handling equipment
   - aeration piping
   - perforated floors

   There is a major problem with fully perforated floors. They cannot be lifted for cleaning and they get clogged and infested. This is an engineering problem and fumigation is costly and not always effective.
3. It is obvious that new grain must never be stored with old because any insects will spread from the old grain to the new.
4. After clean up, repair storage facilities so that they are pestproof.
5. Any remaining insects that would infest the grain can be killed by spraying the empty bins. Use 250-330 mL of malathion 500 EC in 5 L of water. This will treat 100 m^2 of bin surface. **Treat bins two weeks before grain storage.** Sprays are not a substitute for a thorough and complete clean-up. If bin surfaces are dusty or covered with caked material the spray will not penetrate or adhere to kill crawling insects.
6. Leave space between feed rooms and storage facilities because feed rooms are difficult to keep free of pests and insects can quickly spread to nearby storage facilities. For the same reason grain should not be stored in buildings that shelter animals or hay because mangers, feed boxes and troughs are often insect-infested. In addition, such buildings are warmer and thus insects can remain active throughout winter.
7. Molds, as well as insects are much more troublesome in moist grain. If stored grain has more than 14% moisture check it regularly.
8. Using aeration to cool down grain in the fall will reduce insect infestations. Insects do not develop in grain with temperatures below 18°C. Best grain temperature for long term storage is 5°C to 10°C.

The above program of sanitation and pest proofing usually prevents pest problems. However, inspect and sample grain regularly. Should an insect problem develop in storage, seek OMAF Publication 229, *Insects in Farm Stored Grain*, for recommendations on fumigating. Agriculture Canada Publication 1595, *Insects and Mites in Farm Stored Grain in the Prairie Provinces* is also useful.

Precautions

When handling fumigants follow the safety directions given on the manufactured product. Always work in pairs. Wear the recommended gas mask. Remove livestock or poultry that are in the same building, especially if they are under the grain bin.

Some people experience allergic reactions to grain dust and/or molds. Dust masks or respirators will help prevent this when handling grain.

WEED CONTROL IN CEREAL CROPS

For weed control recommendations see OMAF Publication 75: *1986 Guide to Chemical Weed Control.*

FIELD BEANS AND FIELD PEAS

FIELD BEANS

CROP MANAGEMENT

In both white beans and kidney beans, row widths of 70-75 cm are standard due to the nature of the harvesting equipment. For white beans plant 16 to 20 seeds/metre of row (40 to 45 kg/ha). For kidney beans, a seeding rate of 10 seeds per metre (67 kg/ha) is recommended. These seeding rates should result in the highest yield with a minimum of disease problems.

In areas of 2600 to 2900 heat units white beans should be planted between May 20 and June 10. In areas with greater than 2900 heat units, planting should occur between June 5th and 20th.

Kidney beans are normally planted during the first 10 days of June. Planting at this time permits the crop to mature during mid-September when adequate harvest conditions are likely to exist.

Table 52 . Field Bean Variety Recommendations

Variety	Heat Unit Rating	Yield[1] t/ha	Days to[1] Maturity	100[1] Seed wt. (g)	Disease Reaction[2] White Mould Infection (%)	Bean Common Mosaic Virus	Anthracnose Delta-race
Northland	2500	2.0	85	17.0	28	R	S
OAC Seaforth	2550	2.2	89	19.2	37	R	R
Seafarer	2550	2.2	88	18.8	35	R	S
Midland	2650	2.5	92	16.3	44	R	S
Harokent	2700	2.2	95	23.1	25	R	R
Kentwood	2700	2.4	94	22.4	38	S	S
Wesland	2700	2.5	94	19.6	37	R	S
Ex Rico 23	2800	2.7	98	20.1	20	R	S
OAC Rico	2800	2.6	100	19.3	24	R	R
Fleetwood	2900	2.7	99	18.9	48	R	S
Harofleet	2900	2.7	101	19.1	39	R	R
Steuben[3] Yellow-Eye	2850	2.3	100	44.5	24	S	S

[1] *Three-Year Average over 18 tests.*

[2] *See also Disease and Insect Recommendations. R(resistant); S(susceptible)*

[3] *May be deleted from the recommended list in 1987*

FIELD PEAS

VARIETY RECOMMENDATIONS

Century Areas north of 2900-heat-unit line, (see *Heat Units Available for Corn Production,* Figure 1). Seed is medium size, smooth and rounded, yellow; used for soup, either whole or split. Flowers are white; matures midseason.

Trapper Areas north of the 2900-heat-line, (see *Heat Units Available for Corn Production,* Figure 1). Seed is small size, smooth and rounded, yellow; matures five days earlier than Century.

FERTILIZERS FOR FIELD BEANS AND PEAS

Soil Testing

Fertilizer requirements for beans and peas in Ontario can best be estimated by using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes), annual testing is advisable as potash soil tests can change rapidly under those conditions.

Plant Analysis

Plant analysis is a useful supplement to soil testing for evaluation of fertilizer requirements and for diagnosing nutrient deficiencies of field beans. It is quite independent of soil testing and for phosphorus, potassium, magnesium and manganese it is a very useful "second opinion". For nitrogen and zinc it has not been very reliable. For boron and copper we do not have a reliable soil test so plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies. Interpretation of plant analysis is not available for peas.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately.

For field beans the top fully developed leaf (three leaflets plus stem) at first flowering is recommended. However plants suspected of nutrient deficiency should be sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at flowering.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis Section* in *Soils*.

Table 53 . Interpretation of Plant Analysis for Field Beans[1]

Nutrient	**Units**	**Critical Concentration**[2]	**Maximum Normal Concentration**[3]
Nitrogen	%	4.0	5.5
Phosphorus	%	0.15	0.50
Potassium	%	1.2	2.5
Calcium	%	—	5.0
Magnesium	%	0.10	1.00
Boron	ppm (ug/g)	10	55
Copper	ppm	4	30
Manganese	ppm	14	100
Zinc	ppm	14	50

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Nitrogen

Nitrogen fertilizers are not usually required for field beans and peas but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate. Where field bean yields have been low due to bronzing or root rots, apply an additional 100 kg nitrogen per hectare before planting. Under these conditions nitrogen will increase yield but will will not cure the bronzing or the root rot.

Phosphate and Potash

Phosphate and potash requirements for field beans and peas are presented in Table 54. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil testing laboratory.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Table 54);

b. If the field has received little fertilizer in the past, use one of the rates recommended for LOW soil test rating (see Table 54).

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Methods of Application

Fertilizer should not be placed in contact with bean or pea seeds. The fertilizer may be broadcast and plowed down or worked in before planting, or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed.

Micronutrients

Zinc deficiency has been reported on field beans in Michigan but appears to be very rare in Ontario. Other micronutrient deficiencies have not been diagnosed in peas and beans. Beans are very sensitive to boron and should not be grown the year after rutabagas receiving boron.

Table 54 . Phosphate and Potash Requirements for Field Beans and Peas Based on OMAF Soil Tests

Phosphorus Soil Test	**Rating**	**Phosphate (P_2O_5)**[1] **Required — kg/ha**	**Potassium Soil Test**	**Rating**	**Potash (K_2O_5)**[1] **Required — kg/ha**
0 - 3		80	0 - 15		120
4 - 5		60	16 - 30		110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9		40	46 - 60		80
10 - 12		30	61 - 80		60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
16 - 25	HIGH	0	101 - 120		30
26 - 60	VERY HIGH	0	121 - 150	HIGH	0
61+	EXCESSIVE[2]	0	151 - 250	VERY HIGH	0
			251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Example of fertilizer application: If a field bean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphorus requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha of 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

DISEASE AND INSECT CONTROL IN FIELD BEANS

(see also Pesticides section)

Seed Treatment

Follow the precautions under *Seed Treatments* in the *General Information on Pesticide Usage* section when applying any chemical seed treatment.

Seed treatments containing diazinon, lindane and a fungicide are required to protect large-seeded crops from seed maggots, wireworms and seed decay organisms. (See Precautions with Pesticides section).

Application of the insecticides alone may result in reduced germination. Diazinon is used to control seed maggots; lindane to control wireworms and the fungicide to control disease organisms. The combination seed treatment should be applied every year.

Combinations of diazinon, lindane and captan are available from seed suppliers in individual containers. Directions stated on the container should be followed with care; the mixing in the planter box must be thorough or germination will be reduced and insect control will be poor. For your protection while mixing the chemicals with the seed, use a wooden paddle and wear rubber gloves and a respirator. Do not breathe the dust stirred up during mixing.

DISEASES

General Preventative Measures

1. All equipment used for cleaning, conveying or planting of seed should be thoroughly washed with detergent to remove all soil. The equipment should then be disinfected with a quaternary ammonium compound (eg. Niagara HY-X) or sodium hypochlorite (eg. 10% Javex). Rinse off the disinfectant with clean water to limit rusting of treated surfaces.
2. Use a two-to three-year rotation.
3. Do not apply manure containing bean refuse to land intended for beans.
4. Stay out of bean fields when the foliage is wet to avoid spreading diseases.

Bacterial Blight All bean varieties are susceptible to common bacterial blight but are resistant to Halo Blight. The Bacteria usually do not overwinter in the field but, to be safe, allow one year between crops. Almost all infections begin from infected seed. **Do not plant seed which has been harvested from diseased plants.**

Anthracnose The currently recommended varieties of white bean are resistant to alpha, beta and gamma races of anthracnose. Consult Table 52 for varieties resistant to the delta race.

The fungus survives from year to year on seed and on infected plant straw, in the soil and on farm machinery. Rainy weather favors this disease as spores are splashed from diseased areas and carried in wind-borne water droplets throughout the field. For varieties susceptible to the delta race, plant anthracnose-free seed. When the disease condition of the seed is not known, treat with DCT at the recommended rates. This product will not control anthracnose if seed is severely infested. DCT may not contain sufficient diazinon to control seed corn maggot when severe.

Root Rot and Bronzing (ozone damage) occur in almost every field every year. The amount of damage is related to the general health of the crop as well as to the amount of root-rotting organisms in the soil or ozone in the air. Beans which are not growing well have more injury from root rot and bronzing than vigorous beans. Eliminating these diseases is impossible. Yield losses caused by them can be reduced by following good soil management practices.

1. Increase nitrogen levels; see Fertilizers for Field Beans and Peas.
2. Keep organic matter as high as possible.
3. Maintain or build up good soil tilth by not overworking the soil or working it when it is too wet.

White Mold (Sclerotinia) usually begins to appear by mid August. The fungus disease develops from windblown spores produced from small black bodies (sclerotia) that survive in the soil over winter. The sclerotia are found on and in stems and pods of infected plants and at harvest are scattered over the soil. These sclerotia are not toxic to livestock. Initial infection occurs on plant tissues such as older flowers or possibly lower leaves that have died from other causes. Infection of healthy pods, stems and leaves results from infected plant parts coming in contact with healthy plant tissues. Weather conditions, especially rainfall, play a critical role in disease development. In areas where disease is widespread, crop rotation has not given control. Spraying with fungicides is considered essential in fields with the following conditions.

- a past history of white mold;
- above average foliage growth;
- exposure to continuous wetness and air temperatures between 15 to 20°C (day and night temperatures) for more than 48 hours (fewer hours if temperatures are higher).

For most effective control, foliar sprays must be applied at first bloom prior to appearance of disease. Sprays applied after disease first appears do not control white mold effectively.

Table 55. White Mold Control

Fungicide	Formulation[1]	Product per ha
Benlate	50 W	1.75-2.25 kg
Rovral	50 W	1.0 kg-1.5 kg
Easout	70 W	1.75-2.25 kg
Botran	75 W	3.25 kg

[1] *W (wettable).*

DO NOT feed bean refuse to livestock.

INSECTS

Green Cloverworm is a greenish caterpillar that feeds on bean foliage, causing holes in leaves and reducing yield. Shake worms from plants onto paper to count them. If more than five caterpillars are found per 30 cm of row, apply an insecticide as listed below:

Table 56. Cloverworm Control

Insecticide	Formulation[1]	Product per ha	Days to Harvest
Endolsulfan	400 EC	1.4 L	2
or Thiodan	4 EC		
*Guthion	50 WP	1.1 kg	3
	240 SC	1.75-2.25 L	

* *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

[1] *EC (Emulsifiable Concentrate); SC (Sprayable Concentrate); WP (Wettable Powder).*

Mexican Bean Beetles and Potato Leafhoppers cause damage some years. Growers should check the descriptions below and treat their plants when insects are causing damage.

Mexican bean beetles are oval in shape with 16 small black spots on their otherwise yellowish back. The larvae are easily identified by their yellow color and the presence of six rows of long branching, black-tipped spines.

Potato leafhoppers are pale green, wedged-shaped insects about 0.3 cm long. They are best identified by observing how they walk. They can walk equally well forwards, backwards and sideways when disturbed.

Leafhoppers are more likely to cause reductions in yield when they are numerous early in the season and the crop is under stress from drought. When control is necessary, apply one of the insecticides in the table. A second application may be necessary; recheck the fields.

Table 57 . Mexican Bean Beetle and Leafhopper Controls

Insecticide	Formulation[1]	Product per ha	Days to Harvest	Comments
Cygon	480 E	0.7-1.0 L	7	Do not use straw for feed or bedding.
Endosulfan	400 EC	1.4 L	2	
or Thiodan	4 EC	1.4 L	2	
*Guthion	240 SC	2.25 L	3	
Malathion	500 EC	1.3-2.5 L	1	
Sevin XLR[2]	480 Su	1.25-2.5 L	3	Use lower rate for bean beetles.

* *Minimum period before reentry into treated area is 48 hours. See Reentry in Treated Areas section.*

[1] *E or EC (Emulsifiable Concentrate); SC (Sprayable Concentrate); Su (Suspension).*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

Grasshoppers Maintain weed-free headlands and fence-rows. If grasshoppers become a problem, spray outer rows of the field.

Table 58 . Grasshopper Control

Insecticide	Formulation[1]	Product per ha	Days to Harvest
Diazinon	50 WP	1.1 kg	7
Malathion	25 WP	3.4 kg	7
	500 EC	1.7 L	
Sevin XLR[2]	480 Su	1.25-2.25 L	3

[1] *E or EC (Emulsifiable Concentrate); WP (Wettable Powder); Su (Suspension)*

[2] *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

WEED CONTROL IN FIELD BEANS AND PEAS

For weed control recommendations see OMAF Publication 75, *1986 Guide to Chemical Weed Control.*

SOYBEANS

CROP MANAGEMENT

Soybeans should be planted from May 15 to May 30. Later planting will cause marked yield decreases. Choose a variety that will mature every year in your locality. See Heat Units Available for Corn Production, Figure 1.

When you intend to sow fall wheat following a soybean crop, consider a soybean variety earlier than a full-season variety for your area.

When seeding, make allowance for variety seed-size differences. A seeding rate of 67 kg/ha (1 bu/ac) is adequate for all varieties in 36 to 71 cm rows. Eighteen centimetre rows are recommended under short growing season conditions. Adjust seeding rate upward for lower germination or for soils which crust badly. Uniform depth of seeding 3 to 5 cm is important.

Table 59 **. Seeding Rate**

	Row Width (centimetres)			
	18	36	53	71
	Number of Seeds/Metre of Row[1]			
	10	15	21	29
Number of Seeds/Kilogram	Seeding Rate[2] (kg/ha)			
4000-5000 (Large Seeds)	154-123[3]	115-92	115-92	115-92
5000-6000	123-103	92-77	92-77	97-77
6000-7000	103-87	77-67	77-67	77-67
7000-8000 (Small Seeds)	87-78	67-58	67-58	67-58

[1] *18-cm row width calculations based on a stand of 500,000 plants per hectare 36-cm and wider row width calculations based on a stand of 400,000 plants per hectare.*

[2] *Calculations are adjusted fo 90% seed germination.*

[3] *kg/ha x .9* = lb/ac

Inoculation

When soybeans are grown on land for the first time, inoculation with soybeans rhizobia is essential for high yields. Under these conditions, soil-applied granular inoculants produce more consistent nodulation and higher yields than seed-applied powders. Therefore, granular inoculant is recommended on new soybean land, at rates from 5 kg/ha in wide rows up to 10 kg/ha in rows 18 cm apart.

Granular inoculant is applied through granular insecticide applicators on a corn planter, with delivery tubes brought forward to place the inoculant in the seed furrow. In a grain drill, the grass seed box can be used for granular inoculant with tubing added to drop the inoculant with the seed. With newer drills, the granular inoculant may be applied through the fertilizer hopper. After nodulated soybeans have been grown on a field, the use of granular inoculant is not recommended because it usually does not cause yield increases.

If soybeans have only been grown for one or two years, or if they have not been grown for several years, soybean seed should be inoculated with powdered peat inoculant to ensure nodulation. For growers using powdered inoculant, use of a sticker will ensure uniform adhesion to the seed. The seed treatment Anchor serves as a sticker as well as a fungicide.

In fields which have grown soybeans many times, inoculation is not necessary.

VARIETY SELECTION

Table 60 **. Soybean Variety Recommendations and Description**

Variety	Heat Units Required	Hilum Colour	Seeds Per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Powdery Mildew R=Resistant S=Susceptible	Distributor[2]
Maple Ridge[3]	2400	yellow	6450	21	S	SeCan Members
Baron[3]	2450	dark brown	5530	11	S	W.G. Thompson & Sons Ltd.
Maple Amber[3]	2450	brown	5530	11	S	Public variety
Maple Isle	2500	yellow	5240	32	S	SeCan Members
Maple Arrow	2600	brown	5290	20	R	Public variety
KG 30	2600	dark brown	6210	26	S	King Agro Inc.
Bicentennial	2600	brown	4500	7	R	SeCan Members
Apache[3]	2600	gray	5260	24	S	W.G. Thompson & Sons Ltd.
OAC Libra	2650	black	5850	16	S	SeCan Members
Evans	2700	yellow	5880	28	R	Public variety
KG 60	2700	buff	5100	18	S	King Agro Inc.
0877	2750	lt. gray	5560	29	S	Pioneer Hi-Bred Ltd.
Ace[3]	2800	yellow	4070	19	S	W.G. Thompson & Sons Ltd.
J82	2800	dark brown	6540	34	S	Jacques Seed Co.
Crusader	2850	yellow	6320	23	S	W.G. Thompson & Sons Ltd.
Hodgson	2900	buff	5850	14	S	Public variety

(Continued on Page 40)

Table 60. Soybean Variety Recommendations and Description *(Cont'd)*

Variety	Heat Units Required	Hilum Colour	Seeds Per Kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Powdery Mildew R=Resistant S=Susceptible	Distributor[2]
1282	2900	buff	5150	26	S	Pioneer Hi-Bred Ltd.
OAC Pisces	2900	buff	5750	7	R	SeCan Members
A1564	2900	yellow	5810	15	S	Maple Leaf Mills Ltd.
AP10	2900	yellow	6020	28	S	King Agro Inc.
B152	2900	yellow	5950	2*	R	Northrup King Seeds Ltd.
KG 80	2900	yellow	5950	16	S	King Agro Inc.
S15-50	2900	yellow	6750	5	S	Northrup King Seeds Ltd.
S1346	2900	yellow	5560	9	R	Northrup King Seeds Ltd.
KG 71	2900	buff	6130	15	S	King Agro Inc.
S14-60	2900	buff	6030	3	S	Northrup King Seeds Ltd.
A1937	2950	buff	6100	11	R	Maple Leaf Mills Ltd.
A1895	2950	black	5730	3	S	Maple Leaf Mills Ltd.
Hawk	3000	black	5710	4	R	W.G. Thompson & Sons Ltd.
1677	3000	yellow	6760	24	S	Pioneer Hi-Bred Ltd.
B203	3050	yellow	6370	5*	S	Northrup King Seeds Ltd.
Coles	3050	yellow	5320	18	S	Public variety
A2575	3100	buff	5750	17	S	Maple Leaf Mills Ltd.
B220	3100	yellow	5990	29	S	King Agro Inc.
Elgin	3100	black	5560	10	R	Public variety
Jewel	3100	yellow	5990	34	S	W.G. Thompson & Sons Ltd.
Premier	3100	yellow	6140	8	S	King Agro Inc.
S23-03	3100	buff	5880	6	R	Northrup King Seeds Ltd.
S24-24	3100	yelow	6210	2*	S	Northrup King Seeds Ltd.
Corsoy 79	3150	yellow	6330	6*	S	Public variety
Harcor	3150	yellow	6060	26	S	Public variety
Merlin	3150	yellow	6170	8*	S	W.G. Thompson & Sons Ltd.
J103	3200	yellow	5750	20	R	Jacques Seed Co.
A2943	3250	brown-black	6170	7	S	Maple Leaf Mills Ltd.
A3127	3300	black	6580	8	R	Maple Leaf Mills Ltd.

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* *Varieties with multi-race resistance to the prevalent races of the Phytophthora root rot organism.*

[1] *Three-year average (1983-85) in a field heavily infested with Phytophthora. Not all races of Phytophthora root rot are found at this site. Thus the relative ranking of varieties for plant loss may differ in fields that have other races present.*

[2] *See Distributor Addresses in General Section.*

[3] *Metribuzin should not be used on Maple Ridge, Baron, Maple Amber, Apache, or Ace.*

Table 61. Agronomic Data

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index (%)	Days from Planting to Maturity	Plant Height (cm)	Lodging 1=standing 5=flat
3 year average of 10 trials at Brussels, Elora, Inkerman and Ottawa	Maple Ridge	2400	2.2	85	103	57	1.0
	Baron	2450	2.3	88	105	63	1.2
	Maple Amber	2450	2.3	88	106	66	1.2
	Maple Isle	2500	2.4	92	109	56	1.1
	Maple Arrow	2600	2.6	100	113	71	1.2
	KG 30	2600	2.7	104	113	69	1.1
	Bicentennial	2600	2.7	104	115	73	1.8
	Apache	2600	2.7	104	116	65	1.1
	OAC Libra	2650	2.9	112	120	78	1.7
	Evans	2700	2.8	108	124	77	1.6
	Average Yield		2.6				

Table 6 1. Agronomic Data

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index (%)	Days from Planting to Maturity	Plant Height (cm)	Lodging 1=standing 5=flat
3 year average of 8 trials at Centralia, Woodstock and London	Maple Arrow	2600	2.7	93	108	74	1.4
	Bicentennial	2600	2.9	100	109	77	2.1
	Apache	2600	2.7	93	111	70	1.3
	OAC Libra	2650	2.9	100	113	81	1.7
	Evans	2700	2.8	97	115	81	1.6
	KG 60	2700	3.2	110	116	65	1.4
	0877	2750	3.0	103	117	81	1.5
	Ace	2800	2.9	100	118	72	1.4
	J82	2800	2.8	97	118	88	1.6
	Crusader	2850	2.9	100	119	87	1.7
	Hodgson	2900	2.9	100	121	86	1.5
	1282	2900	3.0	103	121	85	1.7
	OAC Pisces	2900	2.9	100	121	78	1.7
	1346	2900	3.0	103	123	74	1.5
	A 1564	2900	2.9	100	124	93	2.0
	Average Yield		2.9				
3 year average of 8 trials at Fingal (Silt Loam), London (Clay Loam), Ridgetown (Clay Loam) and Inwood (Clay)	Crusader	2850	3.2	100	120	86	2.4
	1282	2850	3.0	94	121	83	2.1
	Hodgson	2900	3.2	100	122	84	1.7
	S15-50	2900	3.2	100	122	91	1.7
	KG 71	2900	3.1	97	122	74	1.6
	AP10	2900	3.1	97	123	84	2.3
	S1346	2900	3.2	100	123	75	1.4
	A1564	2900	3.1	97	124	93	2.6
	B152	2900	3.4	106	124	76	1.7
	S14-60	2900	3.2	100	124	78	1.6
	A1937	2950	3.3	103	125	86	2.2
	A1895	2950	3.3	103	125	84	1.9
	1677	3000	3.2	100	126	84	1.9
	Hawk	3000	3.4	106	128	79	2.9
	B203	3000	3.1	97	128	83	1.9
	Coles	3050	3.1	97	130	104	3.3
	Premier	3100	3.2	100	131	88	2.3
	A2575	3100	3.3	103	132	94	1.8
	Average Yield		3.2				
3 year average of 11 Trials at Chatham (Loam), Tilbury (Clay), Woodslee (Clay), and Malden (Loam)	A1564	2900	3.2	97	113	82	1.7
	AP10	2900	2.9	88	113	72	1.7
	B152	2900	3.3	100	113	65	1.2
	Hodgson	2900	3.2	97	113	77	1.6
	KG 80	2900	3.0	91	113	83	2.1
	S1346	2900	3.2	97	114	68	1.1
	A1937	3000	3.4	103	116	80	1.5
	Hawk	3000	3.2	97	116	74	2.0
	1677	3000	3.1	94	116	74	1.8
	B203	3050	3.2	97	118	76	1.6
	Coles	3050	3.1	94	119	89	2.2
	A2575	3100	3.3	100	120	82	1.3
	Premier	3100	3.2	97	120	78	1.6
	B220	3100	3.3	100	121	98	1.4
	Elgin	3100	3.5	106	121	75	1.8
	Jewel	3100	3.5	106	122	73	1.6
	S23-03	3100	3.5	106	122	83	1.7

(Continued on Page 62)

Table 61. Agronomic Data *(Cont'd)*

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index (%)	Days from Planting to Maturity	Plant Height (cm)	Lodging 1=standing 5=flat
	S24-24	3100	3.4	103	122	87	2.0
	Corsoy 79	3150	3.3	100	123	90	2.0
	Harcor	3150	3.3	100	123	90	2.2
	Merlin	3150	3.3	100	123	87	2.0
	J103	3200	3.3	100	125	79	1.6
	A2943	3250	3.5	106	130	87	1.3
	A3127	3300	3.6	109	132	84	1.5
	Average Yield		3.3				

[1] *t/ha = 1 tonne/hectare = 15 bu/ac.*

[2] *For each test Yield Index is expressed as a percentage of the average yield of all recommended varieties growth in that test area.*

FERTILIZERS FOR SOYBEANS

Soil Testing

Fertilizer requirements for soybeans in Ontario can best be estimated by using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations, each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes) annual testing is advisable as potash soil tests can change rapidly under those conditions.

Plant Analysis

Plant analysis is a useful supplement to soil testing for evaluation of fertilizer requirements for soybeans. It is quite independent of soil testing and for phosphorus, potassium, magnesium and manganese it is a very useful "second opinion". For nitrogen and zinc it has not been very reliable. For born and copper we do not have a reliable soil test so plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Problem areas should be sampled separately.

For soybeans the top fully developed leaf (3 leaflets plus stem) at first flowering is sampled as soon as the problem appears. Expert help will be required to interpret plant analysis results when the samples are not taken at flowering.

A soil sample should be taken from the same area and at the same time as a plant sample.

For more information on plant analysis see *Plant Analysis* section in *Soils*.

Table 62. Interpretation of Plant Analysis for Soybeans[1]

Nutrient	Units	Critical Concentration[2]	Maximum Normal Concentration[3]
Nitrogen	%	4.0	6.0
Phosphorus	%	0.15	0.50
Potassium	%	1.2	2.5
Calcium	%		3.0
Magnesium	%	0.10	1.00
Boron	ppm (ug/g)	20	55
Copper	ppm	4	30
Manganese	ppm	14	100
Molybdenum	ppm	0.5	5.0
Zinc	ppm	12	80

[1] *Values apply to the top fully developed leaf (3 leaflets plus stem) at first flowering.*

[2] *Yield loss due to nutrient deficiency is expected with nutrient concentrations at or below the "critical" concentration.*

[3] *Maximum normal concentrations are more than adequate but do not necessarily cause toxicities.*

Nitrogen

Where soybeans have not been grown recently, the seed should be inoculated with nitrogen fixing bacteria before seeding. See *Inoculation* in the *Soybean Crop Management* secion.

Nitrogen fertilizers are not usually required for soybeans but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate.

Phosphate and Potash

Phosphate and potash requirements for soybeans are presented in Table 63. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Table 63. Phosphate and Potash Requirements for Soybeans Based on OMAF Soil Tests

Phosphorus Soil Test	Rating	Phosphate (P_2O_5)[1] Required - kg/ha	Potassium Soil Test	RATING	Potash (K_2O_5)[1] Required - kg/ha
0 - 3		80	0 - 15		120
4 - 5		60	16 - 30		110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9		40	46 - 60		80
10 - 12		30	61 - 80		60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
			101 - 120		30
16 - 25	HIGH	0	121 - 150	HIGH	0
26 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61+	EXCESSIVE[2]	0	251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils). Example of fertilizer application: If a soybean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphate requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha 6-24-24 fertilizer.*

[2] *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating. (See Table 63).

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil rating. (See Table 63).

Some clay and clay loam soils are naturally high in potassium and do not require any potassium fertilizer. Only a soil test can adequately determine potash requirements.

Micronutrients

Manganese is the only micronutrient deficiency diagnosed in soybeans in Ontario although zinc deficiency may show up in the future where the surface soil has been lost by erosion.

With Manganese deficiency, the upper leaves range from pale green (slight deficiency) to almost white (severe deficiency) while the veins remain green. In addition to deficiency symptoms both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory.

Correct the deficiency as soon as detected by spraying the foliage with 2 kg of manganese/ha from manganese sulfate (8 kg of manganese sulfate/ha) or 0.4 kg of manganese/ha in chelated form in 200 L of water.

A "spreader-sticker" in the spray is recommended for materials other than chelates. If the deficiency is severe, a second spray may be beneficial.

Never use spray equipment which has been used for spraying hormone-type herbicides such as 2,4-D. Beans are very sensitive to this type of herbicide.

Soil application is not a recommended way to apply manganese regardless of the source because of the large amounts required. Manganese chelates should not be applied to the soil.

For further details on manganese deficiency and on methods of applications refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Fertilizer should not be placed in contact with soybean seeds. The fertilizer may be broadcast and plowed down or worked into the soil either in the fall or spring; or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed.

DISEASE AND INSECT CONTROL IN SOYBEANS

(see also Pesticides section)

Seed Treatments

Follow the precautions under *Seed Treatments* in *General Information in Pesticide Usage* section, when applying any chemical seed treatment.

Seed treatments are recommended for control of seed decay, damping-off, and seedling blight which are caused by various seed-borne and soil-borne fungi. These diseases reduce germination, plant stand and yield.

Seed treatments are recommended also for control of seed maggots and wireworms in areas where these insects are a problem. Seed maggots usually are damaging on lighter soils high in organic matter. Wireworms may be a problem in soybeans that follow sod or pasture. The recommended insecticides are Diazinon and Lindane, but they can cause seedling injury when one or both are used. The addition of a fungicide such as captan makes these products safer on soybeans seed and in addition controls seed decay and seedling diseases.

Among the products containing Diazinon, Lindane and captan only B-3 (D-L-C) contains sufficient captan fungicide to be used on untreated soybean seed. D-L-C, D-L Plus and D-L+C contain about half as much captan as needed, and therefore should only be used on seed previously treated with captan, Vitaflo-280 or Vitavax powder.

Table 64. Soybean Seed Treatments for Disease and Insect Control

Products	Active Ingredients	Formulation[1]	Diseases Controlled			Insects Controlled	
			Phomopsis Seed Mold	Rhizoctonia Damping Off	Other Seed Decay and Seedling Blight[2]	Seed Maggot	Wireworm
B-3 (D-L-C)	Diazinon Lindane Captan	P-DB	—	—	+	+	+
D-L-C D-L Plus D-L + C	Diazinon Lindane Captan	P-DB	—	—	+[3]	+	+
Anchor	Carbathiin Thiram	L	+	+	+	—	—
Vitaflo-280	Carbathiin Thiram	S	+	+	+	—	—
Vitavax Powder	Carbathiin Thiram	P-DB	+	+	+	—	—
Captan	Captan	F or P	—	—	+	—	—

[1] *P-DB (Powder Drill Box); S(Flowable Suspension); F(Flowable); P(Powder); L(Liquid);*

[2] *Caused by other soil fungi especially Pythium.*

[3] *Effective only when applied to seed already treated with captan.*

+ *Recommended for disease listed*

— *NOT recommended*

In areas where insect problems are minimal, use seed treatments containing fungicide only, such as captan, Anchor, Vitaflo-280 or Vitavax powder.

DISEASES

Phomopsis seed mold develops near harvest when weather is warm and wet. Fine cracks usually develop in the coat of the infected seed, especially near the hilum. A white or grey mold may be visible on the seed surface. The yield, grade, viability and vigour of the seed can be reduced. Whenever possible, grow full-season varieties that mature during the cool weather late in the growing season. Varieties that are short-season for an area tend to mature earlier when conditions are warmer and more favorable for seed mold. Seed treatment (Table 64) usually increases germinability of seed. However distorted seed with visible fungal growth often fails to germinate, even when treated. Rotating soybeans with other crops and plowing under crop residues help to reduce disease severity.

Powdery Mildew develops on the leaves usually in August and September. White powdery growth of the mildew fungus appears on the upper surface of the leaf. The seeds do not become infected. Yield losses usually occur only when outbreaks of powdery mildew begin early, in July, and remain severe until maturity. Cool cloudy weather favors the disease. Certain varieties are resistant to powdery mildew (Table 60).

Downy Mildew appears as yellow, and later, brown spots on the leaves during August and September. In moist weather a pale blue to gray, downy growth of the mildew fungus appears on spots on the lower leaf surface. Severely affected leaves may drop prematurely. Whitish growth of the fungus may encrust the seeds, even within pods that appear healthy. Varieties differ in susceptibility; the variety **Evans** is highly susceptible, but **Maple Arrow** has considerable resistance. Rotate soybeans with other crops and plow under crop refuse.

Phytophthora Root Rot is a potential problem in heavy clay soils in southwestern Ontario. The disease has also been observed in central and eastern Ontario. Seedlings may be killed prior to emergence or plants may be killed any time before maturity. A reddish-discolouration extending from the roots to the lower nodes is evident on the stems of wilted plants. Dead plants may occur as either a few in a row or as patches in low areas of fields. Control of Phytophthora root rot requires a combination of soybean variety selection and good soil management.

Soybean varieties with resistance or tolerance to Phytophthora root rot are available (Table 60). Some varieties have both resistance and tolerance.

1. Resistant varieties. The Phytophthora fungus is present in Ontario soils as a series of races (or "strains"). Resistance in any one soybean variety is effective against some but not all of the races. Root rot is controlled in a particular field when the variety grown is resistant to all of the Phytophthora races that happen to be present in that field. Resistance will "break down", however, should another race appear to which the variety is not resistant. If this occurs, use a tolerant variety.
2. Tolerant varieties. Some disease develops in these varieties when grown in infested soils, regardless of which races of Phytophthora are present. However yields of tolerant varieties usually are not seriously reduced by the disease.

Any soil management practice which reduces soil compaction or waterlogging will decrease the incidence of Phytophthora root rot. On clay soils where the disease may be a problem, the following procedures are recommended.

a. Choose a variety with a low percentage of infected plants (see Table 60).

b. Prepare seedbeds by fall plowing and spring tillage.

c. Do not plow or disk when the soil is wet.

d. Plow in crop residues or manure to improve soil structure.

e. Include crops in a rotation which improve soil structure.

f. Inspect each soybean field for dead plants in late July or early August to determine whether or not the variety has enough resistance/tolerance to provide adequate protection under local conditions.

Rhizoctonia Root Rot has been found in most of the soybean growing areas of southwestern Ontario. Symptoms of the disease are very similar to plants infected with Phytophthora, except reddish lesions produced on roots and lower stems seldom extend above the soil line. There are no commercial varieties that are tolerant to Rhizoctonia.

White Mold may cause damage to soybeans under cool, wet conditions. Stems, pods and leaves infected with white mold are pale brown and water-soaked in appearance. Frequently a white cotton-like growth and small dark bodies (sclerotia) can be seen on or within stems of diseased plants. The sclerotia survive many years in soil. In summer, disease arises from airborne spores produced on the sclerotia. Crop rotation may be useful for disease control in areas where white mold is uncommon. White mold is more likely to occur in soybeans following any bean crop in which white mold was present in previous years. Avoid this crop sequence if possible. In areas where white mold is common, however, the disease may appear in spite of crop rotation because of windblown spores from other fields. Some differences in disease severity in varieties have been noted. No resistant varieties have been identified but field observations indicate that early varieties in a geographic area are less prone to an epidemic than later varieties. Similarly, varieties with greater lodging resistance tend to be more resistant to white mold. For soybean fields with a history of severe white mold infection, producers should consider planting varieties which require 200-300 fewer heat units than normally available and which possess superior resistance to lodging.

INSECTS AND MITES

Twospotted mite This insect is an occasional pest of soybeans. The adults are tiny, rounded, eight-legged and vary in colour. They always have two darker spots and hence the common name. Both the adults and the immatures feed on plant juices from the undersides of leaves. Their feeding causes yellowing, curling and bronzing. A close examination will show fine webbing on the lower surface of the leaves and the tiny mites with two dark spots.

There are many generations a year. As grain and other crops mature the mites can move into soybean fields. Four or more mites per leaf or one severely damaged leaf per plant warrant chemical control. If rain is forecast, spraying should be delayed because the rain will usually reduce the number of mites to unimportant levels.

For chemical control, use Cygon 480E at rates listed in Table 57 for Mexican Bean Beetle and Leafhopper Control in the *Field Bean* section.

Insect damage is seldom enough to cause soybean yield losses in Ontario. Green cloverworms may be prevalent in some years. Control measures for green cloverworms and grasshoppers are listed in Tables 56 and 58 in the *Field Bean* section. Follow precautions for handling chemicals. See *Pesticides* section.

WEED CONTROL IN SOYBEANS

For weed control recommendations see OMAF Publication 75, *1986 Guide to Chemical Weed Control.*

SPRING CANOLA AND WINTER RAPESEED

SPRING CANOLA

CROP MANAGEMENT

Spring canola is a cool-season crop suited to areas with less than 2700 heat units.

Seeding should be done as early as soil conditions permit. Planting time should be late April to early May. Yield reductions will occur if seeding is delayed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill or Brillion-type seeder into a fine, firm seedbed. Planting depth should be 2 to 3 cm if there is adequate moisture, and deeper if necessary to plant in moisture, but not deeper than 4 cm. Seed should be mixed with an insecticide for flea beetle control before calibrating the drill.

Canola is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA. Be sure spraying equipment is cleaned out thoroughly before using on canola.

Spring canola should be swathed when 25% of the seeds in pods from the middle portion of the plants have changed color from green to red or brown. Leave as long a stubble as possible. Swathing when the crop is moist aids flow through the swather. Canola in the swath matures in 5 to 10 days under ideal weather. Seed will not store at more than 10% moisture. However, under good drying conditions, moisture content drops rapidly and combining can begin at about 13% moisture.

For additional information see OMAF Factsheet, *Spring Canola in Ontario,* Agdex 149/10.

VARIETY SECTION

Argentine-type varieties are recommended for most areas with less than 2700 heat units. Polish-type varieties such as Candle and Tobin normally yield less than Argentine-type varieties and are only recommended for northern Ontario areas where Argentine-type varieties do not mature regularly.

OAC Triton is an Argentine-type now recommended in Ontario. It is resistant to triazine herbicides (see Weed Control in Canola) which can be used to control wild mustard and other weeds without damaging the crop. Consider growing OAC Triton in fields that have a mustard problem because mustard seed cannot be cleaned out of canola and more than 5% contamination can mean rejection of the canola by elevators or crushers.

Table 65.Recommended Spring Canola Varieties[1]

Variety	Days from Planting to Maturity	Yield[2] (t/ha)	Lodging 1=standing 5=flat
Argentine-type			
Regent	101	2.0	1.7
Westar	98	2.1	1.6
Global	103	2.3	1.2
Hanna	102	2.2	1.5
OAC Triton	102	1.6	2.1
Polish-type			
Tobin	87	2.0	1.7
Candle	87	2.0	1.8

[1] *Values shown are averages of 22 trials over 3 years except for Polish-types which are averages of 21 trials over 3 years.*

[2] *1 t/ha = 893 lb/ac.*

FERTILIZERS FOR SPRING CANOLA

Fertilizer requirements for canola in Ontario can best be estimated using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publications can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations, each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (with crops such as hay, corn silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under these conditions.

Nitrogen

Spring application of 100 kg/ha is recommended unless a legume sod has been plowed down or manure has been applied. (See *Manure and Legumes Plowed Down* sections in Soils).

Phosphate and Potash

Phosphate and potash requirements for canola are presented in Table 66. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing service at Agri-Food Laboratories, Guelph. These tables should not be used with soil test readings from other soil test laboratories unless the methods used are identical to those used in the OMAF laboratory.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines.

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (See Table 66).

b. If the field has received little fertilizer in past, use on of the rates recommended for a LOW soil test rating. (See Table 66).

Some clay and clay loam soils are naturally high in potassium and do not require any potassium fertilizer. Only a soil test can adequately determine potash requirements.

Table 66. Phosphate and Potash Requirements for Spring Canola Based on OMAF Soil Tests

Phosphorus Soil Test	Rating	Phosphate (P_2O_5)[1] Required — kg/ha	Potassium Soil Test	Rating	Potash (K_2O)[1] Required — kg/ha
0 - 3		70	0 - 15		70
4 - 5	Low	60	16 - 30	Low	50
6 - 7		50	31 - 45		40
8 - 9		30	46 - 60		30
10 - 12		20	61 - 80		20
13 - 15	Medium	20	81 - 100	Medium	20
16 - 20		0	101 - 120	High	0
21 - 25		0	121 - 150		0
26 - 30	High	0	151 - 180	Very High	0
31 - 40		0	181 - 210		0
41 - 50	Very High	0	211 - 250		0
51 - 60		0	251+	Excessive[2]	0
61+	Excessive[2]	0			

100 kg/ha = 90 lb/ac

[1] *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure Section in Soils).*

[2] *Excessive ratings may cause reduced yield or quality of the crop.*

DISEASE AND INSECT CONTROL IN SPRING CANOLA

(see also Pesticides section)

Seed Treatment

Canola seed should be treated with a combination of fungicide and insecticide. The fungicide is required to control seed-borne diseases, especially blackleg, seed decay, and damping-off. Insecticides are to control flea beetles on emerging canola. Seed may have been commercially treated. Untreated seed should be treated by the grower. Use the following at rates recommended on the label.

Table 67. Canola Seed Treatments

Seed Treatment	Formulation[1]	Fungicide	Insecticide
Vitavax RS	F	3.3% carbathiin 6.6% thiram	50% lindane
Gammasan+	P	6% benomyl 10% captan	50% lindane

[1] *F(Flowable); P(Powder).*

DISEASES

White mold (Sclerotinia) is characterized by bleached stem lesions, hard black bodies (sclerotia) of the white mold fungus inside the stems, and premature ripening of the plants. The disease is often a problem when canola follows canola, white beans, soybeans or sunflowers. Use clean seed and rotations of at least four years including unaffected crops such as corn, wheat, barley or oats. Treatment with a fungicide may be advisable when conditions favor white mold but the fungicide must be applied **before** symptoms appear. The risk of white mold is high when the disease developed in previous crops, when the canola stand is dense and vigorous, and when several days of wet weather precedes the early flowering stage. Fungicides should be applied at the 20 to 30% bloom stage of canola, in a minimum of 80 l/ha of water with ground equipment, or 45 l/ha of water with aerial application.

Table 68. White Mold Control

Fungicide	Formulation[1]	Product/ha
Benlate	50 WP	1-1.5 kg
Rovral	50 WP	1-1.5 kg

[1] *WP (Wettable Powder).*

INSECTS

Flea beetles Two species of flea beetle attack canola. The striped flea beetle is about 1.5 mm long and has two cream-colored stripes along its back. The crucifer flea beetle is entirely bluish-black and about the same size. Flea beetles jump when disturbed, thus their common name. The adults eat holes through leaves. Larvae feed on the roots of canola and other cruciferous plants but are not considered damaging.

Both kinds of flea beetle overwinter as adults and can attack canola in the spring after germination. Damage is most severe during the initial three weeks following germination, when young seedlings are killed or seriously damaged. Feeding on the foliage continues during the season but more mature plants are less severely affected. Severe infestations in western Canada have caused 50% reductions in yield. The full extent of damage in Ontario is still unknown.

Control measures should be directed against the beetles during the early stages of seedling growth. Seed treatments (Table) should always be used because they provide protection from seed and soil born diseases and protect the young seedlings from flea beetles. (See the preceding section for information on seed treatments.) However, flea beetles can attack suddenly after the effect of the seed treatment is gone so a granular applied with the seed (Table) is also recommended. This combination of seed treatment and granular at planting provides the best protection. Heavily infested areas also may require a foliar spray to control flea beetles. Check the seedling fields regularly, especially along weedy borders. More severe damage is expected in such areas because of the proximity of the overwintering sites of the beetles.

Table.69. Flea Beetle Control

	Formulation[1]	Product per ha	Days to Harvest
Seed-furrow application:			
Counter	5G	5.5-11 kg	Planting time only
Furadan	CR-10G	2.8 kg	
Post-emergent spray:			
**Decis	2.5 EC	200-300 mL	14
*Furadan	480 F	150-275 mL	60
*Guthion	50 WP	150-275 g	30
	240 SC	275-550 mL	30
**Ripcord	400 EC	35-50 mL	30
Sevin XLR	480 Su	500 mL	Within 4 weeks of emergence

[1] *G (Granular); F (Flowable); WP (Wettable Powder); SC (Sprayable Concentrate); EC (Emulsifiable Concentrate); Su (Suspension); CR (Special formulation for Canola Rape)*

* *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

** *See "Temporary Registration of Pesticides" inside front cover.*

Diamondback Moth The adult is a small light brown moth about 1 cm long. It is best identified by the white diamond-shaped markings along the back when the wings are at rest. Apparently this pest does not over-winter in Ontario. The severity of attack is dependant on the number of moths carried into Ontario each spring on weather systems.

Damage is caused by the larvae which are light green with brown heads and are about 1 cm long when mature. There are three or four generations in Ontario. They feed on the foliage and when numerous they will fed on the pods. This damage results in premature senescence and shattering of pods at harvest.

Table 70. Diamondback Moth Control

Product	Formulation[1]	Product per ha	Days to Harvest
Dylox[2]	80% SP	1.5 kg	21
	420 L	2.75 L	21
*Guthion	50 WP	275-550 g	30
	240 SC	.55-1.25 L	30

[1] *SP (Soluble Powder); L (Liquid); WP (Wettable Powder); SC (Sprayable Concentrate).*

[2] *Use Dylox if Canola is in bloom because it is less hazardous to bees.*

* *Minimum period before reentry into treated area is 48 hours. See Reentry into Treated Areas.*

WEED CONTROL IN CANOLA

For weed control recommendations, see OMAF Publication 75: *1986 Guide to Chemical Weed Control.*

WINTER RAPESEED

CROP MANAGEMENT

Under good management, winter rapeseed has superior yield potential than spring canola. Winter rapeseed is suited to areas with good winter snow cover and low risk of ice accumulation.

Winter rapeseed grows best on loam or sandy-loam soils. Poorly drained soils and heavy clay soils should be avoided since root heaving may occur.

Seeding should be done August 15-30 (Aug. 20 - Sept. 10 in Kent and Essex Counties) into a level, firm, moist seed-bed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill. Broadcast seeding is recommended only if soil fertility and tilth are optimal. Plant to a depth of 2 to 3 cm or to moisture, but do not exceed 4 cm. Seed should be mixed with an insecticide for flea beetle control before planting equipment is calibrated.

Winter rapeseed is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA and is also susceptible to triazine herbicides. Swath when 50-60% of the seeds in pods from the middle portion of plants have changed from green to black or direct-combine when seed moisture is 10% or lower, unless drying facilities are available. Winter rapeseed in the swath will be ready to combine in 5 to 10 days under good weather conditions. Be sure seed is at 10% moisture or lower to ensure safe storage.

VARIETY SELECTION

There are no winter canola varieties licensed in Canada. The Argentine-type cultivar **Tandem** is approximately 10 micromoles over the established 'canola' standard of 30 micromoles of glucosinolates per gram of oil-free meal. Tandem, from King Agro Inc., is the only licensed winter rapeseed variety available in Canada and will be replaced when a suitable 'canola' quality cultivar is licensed.

FERTILIZERS FOR WINTER RAPESEED

Nitrogen

On loam and fine-textured soils, no yield response to added fall nitrogen has been observed where winter rapeseed follows fallow or legume plow-down. When following cereals, especially winter wheat, application of up to 40 kg/ha of nitrogen is recommended on loam to clay-loam soils. On sandy soils subject to leaching and low residual nitrogen, yields of winter rapeseed have consistently been improved with fall nitrogen applications of up to 75 kg/ha.

Spring application of 150 kg/ha is recommended for most soil types unless a legume sod has been plowed down or manure applied (See *Manure and Legumes Plowed Down* sections in *Soils*). Sandy soils subject to leaching may require up to 200 kg/ha for maximum yield. Split applications of spring nitrogen have been beneficial only on lighter soils.

Phosphate and Potash

For phosphate and potash recommendations see section on *Fertilizers For Spring Canola.*

DISEASE AND INSECT CONTROL IN WINTER RAPESEED

Seed Treatment

Refer to *Seed Treatment section, Spring Canola.*

DISEASES

Blackleg (phoma) Spots (1-2 cm) with small black bodies appear on the leaves. Stem cankers in severely affected plants may girdle the stems and kill the plants prematurely. Seeds of these plants are shrivelled. Treat seed with a fungicide. (Table 67) to help control seed-borne infections. Use a 4-year rotation with crops other than crucifers.

White mold (Sclerotinia) Refer to *Disease section, Spring Canola.*

INSECTS

Flea beetles Refer to *Insect section, Spring Canola.* Flea beetle damage is generally limited to the fall period in winter rapeseed.

WEED CONTROL IN WINTER RAPESEED

For weed control recommendations, see OMAF Publication 75: *1986 Guide to Chemical Weed Control.*

SOIL MANAGEMENT AND FERTILIZER USE

Ontario currently uses about 1,000,000 tonnes of fertilizers annually. High yields can be produced efficiently only when fertilizer use is related to the fertility level of the soil and to other additions of nutrients in manure, crop residues, etc. At one extreme, on very low fertility soils, it is occasionally profitable to add as much or more nitrogen, phosphorus, or potassium in the fertilizer as a crop removes. At the other extreme, on high fertility soils or following heavy application of manures, fertilizer may not be profitable and occasionally may reduce yields.

SOIL TESTING

Why Soil Test?

Soil testing is currently by far the most accurate tool available to Ontario farmers to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to field crops.

Alternatives to the Soil Test

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.
2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.
3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen, as with some crops the suggested rate applies close to what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser - textured soils.

The soil testing program is the main guide along with help from plant analysis and nutrient deficiency symptoms to determine your fertilizer requirements for a specific crop on a specific field.

What does the OMAF Soil Testing Program Provide for the Farmer?

Fertilizer recommendations based on soil test results are made by Agricultural Representatives. Fruit and Vegetable Specialists and Soils and Crops Specialists, in county and district offices of the Ministry of Agriculture and Food.

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum profits under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done to maintain high soil nutrient levels, and to allow for some error in sampling the field. For high value crops such as tobacco the maximum profit we aim for will require essentially the same amount of fertilizer as maximum crop value (maximum yield with high quality). For low value crops such as oats there may on occasion be a slight yield response to rates of fertilizer above those recommended for maximum profit. However, trials on farm fields with corn have shown no yield response to rates of fertilizer above those recommended by soil test.

Soil Tests from Other Laboratories

Each year a number of farmers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory uses the identical chemical tests used for the OMAF service and expresses their test results in the same units, the OMAF fertilizer requirements for phosphate and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper not provided through the OMAF services. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations leads to less reliable recommendations than are now provided.

Soil Sampling

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken the more likely the soil sample is to provide a reliable measure of the fertility in the field. The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately if they are large enough to fertilize separately. It can be quite informative to sample problem areas separately, occasionally, even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

When to Sample

Each field should be sampled once ever two to three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the grower within five days of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring seeding crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample for some farmers. Soil samples from fields to be fertilized for fall wheat, or from hay and pasture fields to be fertilized in late summer, should be taken in the spring or early summer.

Micronutrient Tests

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper, iron, or molybdenum.

Contamination Great care is required to prevent contamination of soil samples with micronutrients, particularly zinc. Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests. Do not use metal containers to collect and mix samples. Plastic containers in good condition should be satisfactory. Soil samples which have contacted galvanized surfaces are unsatifactory for zinc soil tests. Be careful to keep dust around buildings etc. out of the samples.

Soil Sampling Micronutrient deficiencies frequently occur in small patches in fields. In these cases soil or plant analysis taken from the entire field are unlikely to find the problem. Sample problem areas separately.

Table 71. Manganese Soil Test Interpretation

Manganese Soil Test	Suggested Treatments
greater than 30	Soil manganese availability is adequate for field grown crops.
16 to 30	Soil manganese availability is adequate for many crops but is approaching deficiency levels for oats, barley, wheat and soybeans. If deficiency symptoms appear, spray with manganese. Consider a re-check for deficiency using plant analysis.
below 16	Soil manganese availability is believed to be insufficient for oats, barley, wheat and soybeans. Spray with manganese at the four-leaf stage and again three weeks later if required. Manganese deficiency has not been diagnosed on corn in Ontario even on soils which are very deficient for wheat.

Preventing and Correcting Manganese Deficiency Manganese is less available at high soil pH so it is important not to add more lime than is needed to correct soil acidity. For materials and rates to correct a deficiency, consult the cereals or soybeans sections under *Micronutrients.*

Table 72. Zinc Soil Testing Interpretation

Zinc Soil Test	Suggested Treatments
greater than 200	You should suspect contamination of the sample or of the field.
25 to 200	Soil zinc availability is adequate for most field grown crops.
15 to 25	Zinc availability is adequate for most field crops except corn. Zinc availability is bordering on deficiency for corn. If the field sampled is uneven in soil texture, pH, or erosion, some areas may respond to zinc applications. Deficiency symptoms at the 4 to 6 leaf stage are a reliable indication of zinc deficiency (see OMAF Factsheet 100/531).
less than 15	Zinc is likely to be deficient for corn and should be applied in the fertilizer.

Preventing and Correcting Zinc Deficiency High phosphorus in the soil and/or in the fertilizer can cause or increase the severity of zinc deficiency. Apply only the recommended amount of phosphorus. Use of animal manures can prevent or reduce zinc deficiency. Erosion control can prevent deficiency of zinc by maintaining the topsoil.

Zinc deficiency can be prevented by application of zinc fertilizer to the soil. Foliar sprays can be useful to correct a deficiency after the symptoms have appeared provided this is done early in the growing season. For materials and rates to correct a deficiency, consult the corn section under *Micronutrients.*

Copper soil tests are quite unreliable on Ontario soils but plant analysis is useful. Copper is unlikely to be deficient on mineral soil except perhaps on very sandy soils. Copper deficiency does occur on organic soils and is best diagnosed by plant analysis. When organic soils are first brought into cultivation, copper should be applied to the soil at 8 kg copper/ha for each of the first three years.

Boron is required on some soils for alfalfa. Boron deficiency usually occurs in dry weather so that response is erratic. Thus it has not been possible to develop a reliable soil test. Plant analysis is useful as a predicter of boron requirements as are visual symptoms on the plants. For rates of boron to correct a deficiency, consult the forages section under *Micronutrients.*

Boron deficiency has not been diagnosed on cereals, peas and beans in Ontario and boron applications to these crops, or applied to other crops in the year preceding them, can be toxic. Boron should not be banded at seeding.

Iron and **Molybdenum** have not been found to be deficient in field crops in Ontario.

Sample Boxes and Information Sheets

Soil sample boxes and information sheets may be obtained from any local office at the Ministry of Agriculture and Food or from Agri-Food Laboratories, 503 Imperial Road, Unit One, Guelph, Ontario N1H 6T9.

Management practices which affect a soil test recommendation are: manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

Changes in Crop or Management

Fertilizer requirements on the OMAF soil test report are for specific crop and management. If the crop management is changed in regard to legumes plowed down or manure applied, the adjustments in fertilizer requirements may be made using the manure and legume sod adjustments in Tables 73 and 75. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in the publication.

Nitrogen Adjustment for Legumes Plowed Down

When sod containing perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. The accompanying table shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

Table 73. Adjustment of Nitrogen Requirement Where Crops Containing Legumes are Plowed Down

Type of Crop	For all Crops Deduct from N Requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	110
Soybean and field bean residue	0
Perennial legumes seeded and plowed in the same year.	20[1]

[1] *Applies where the legume stand is thick and over 15 cm high.*

Table74'. Analyses Available through the OMAF Soil Testing Service, at Agri-Food Laboratories, 503 Imperial Road, Unit One, Guelph, Ontario M1H 6T9

Materials	What is Analyzed	Cost Per Sample
1. Field Soils	Plant available Phosphorus, Potassium and Magnesium; pH; Lime requirements; Calcium (on tobacco soil only)	No Charge
2. Home Garden and Lawn Soils	Plant-available Phosphorus, Potassium Magnesium; pH; Lime requirement	$1*
3. Commercial Turf Soil	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	No Charge
4. Greenhouse Media Water** and Nutrient Solutions**	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulphates; Chlorides; Total Salts	No Charge
5. All Soils (optional, on request only)	Plant available Manganese and Zinc	$2*
6. All soils (optional, on request only)	Organic Matter	$5*

* *Prices effective October 1, 1985. Payment must accompany request for analysis.*

** *Laboratory requires 500 ml sample.*

Plant Analysis

Plant analysis measures the nutrient content of plant tissue. Comparing the results against the "normal" and "critical" values for the crop can indicate whether nutrient supply is adequate for optimum growth.

Plant analysis is a useful supplement to soil testing for evaluation of the fertility status of crops. It is quite independent of soil testing and can provide a valuable "second opinion", especially for phosphorus, potassium, magnesium and manganese. For nitrogen and zinc it has not been very reliable. For boron and copper we don't have a reliable soil test so plant analysis and visual symptoms are the only methods for diagnosing deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not always indicate the cause of a deficiency or the amount of fertilizer required to correct it.

Sampling

Time of sampling has a major effect on the results since nutrient levels within a plant vary considerably with the age of the plant. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, plants suspected of being nutrient deficient should be sampled as soon as a problem appears. Samples are best taken from a problem area rather than from the entire field.

Samples for plant analysis should be taken from at least 50 plants distributed throughout the area chosen for sampling. Each sample should consist of at least 30 grams of fresh material. Problem areas should be sampled separately. When taking samples for plant analysis take care not to contaminate the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.

Sample Preparation

Samples of fresh plant material should be delivered directly to the laboratory. If they are not delivered immediately they should be dried to prevent spoilage. Samples may be dried in an oven at 65°C or less or dried in the sun provided precautions are taken to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several laboratories in Ontario.

MANURE

Manure can supply organic matter and an appreciable part of the nutrients required for production of crops.

Manure Storage

For maximum conservation of plant nutrients manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Where to Use Manure

Manure is used most effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates supplying more nitrogen than the crop requires. Corn and grass hay or pastures have higher nitrogen requirements than many other crops and therefore respond more to nitrogen in manure. Legumes such as alfalfa, trefoil and soybeans do not make efficient use of the nitrogen in manure.

Manure on Perennial Legumes

Do not apply manure to perennial legumes such as alfalfa and trefoil when there is snow cover because ice frequently forms under the manure and can kill the plants. If manure must be applied to perennial legumes it should be applied to the thinnest or oldest stands, preferably after the first cutting.

Applications to Cereals

Manure or nitrogen fertilizers applied to cereals at rates supplying more nitrogen than the crop requires can cause lodging and should be avoided.

Manure on Grass Sod

Manure is an effective source of nutrients for grass sod. However, where manure is to be applied in late spring or summer some nitrogen fertilizer should be applied early in the spring.

Manure on Leaves

Avoid application of liquid manure to crop foliage as it can damage the crop. On perennial forages application to the foliage cannot be avoided but applications early in the spring or immediately after haying are preferred.

Short-Term Value of Manure

Table shows the quantities of nutrients in manure applied in the year that the crop is grown. These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure). 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer. Thus the application of fertilizer nitrogen, phosphate and potash should be reduced accordingly.

Long-Term Value of Manure

The long-term availability of phosphorus, potassium or magnesium from manure applications in previous years is best measured by a soil test. Some of the nitrogen in cattle and swine manures also continues to become available in the years following application but in successively smaller quantities. Generally, 50 percent of the total manure nitrogen applied in the spring is available (as available as nitrogen in chemical fertilizer) in the year of application. In the second year approximately 20 percent of the remaining nitrogen becomes available, 10 percent in the third year and 5 percent in the fourth year. Thus if 20 tonnes of cattle manure per hectare were applied, the amount of nitrogen available in the first year would be 48 kg N/ha (Table). This is approximately one half of the total nitrogen content. The amounts of available nitrogen in years 2, 3 and 4 would be 10, 4, and 2 kg N/ha, respectively. If manure has been applied annually for a number of years, the cumulative amount of nitrogen is appreciable. For example, if 20 tonnes of cattle manure were applied each year for four years, the total available nitrogen from the manure in the fourth year would be 48+10+4+2=64 kg N/ha.

Although time and method of manure application affects the amount of available nitrogen in the first year, the amounts available in subsequent years are not affected appreciably. No adjustment should be made for the long-term effects of poultry manure because most of the available nitrogen it contains is released in the year of application.

Time and Method of Application

For most effective use of the nitrogen in manure it should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure between corn rows after seeding, but before the corn is 30 cm high, is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However phosphate applied after a crop is seeded may not be available to that crop. Phosphate fertilizer requirements should therefore not be adjusted for manure applied after seeding.

Where the manure is applied in the fall more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall-and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applied. **Do not spread manure in winter or early spring on fields that are subject to runoff.**

Table 75. Reductions in Fertilizer Application where Manure is Applied in the Same Crop Year[1]

Class of Livestock	Nitrogen (kg/ha)			Phosphate	Potash
	F.&.W.[2]	Spr.[2]	Spr.C[2]	P_2O_5(kg/ha)	K_2O(kg/ha)
Liquid Manure at 10 cubic metres/hectare (900 gal./acre)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare (4.5 tons/acre)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

[1] *These adjustments are based on slightly below average quality manure.*

[2] *F.&W. denotes fall and winter applied manure; Spr. denotes spring applied and not covered immediately, including surface application after seeding; Spr. C. denotes spring applied manure injected or otherwise covered within one day of application.*

Manure Analysis

The nutrient content of manure varies not only with the type of livestock but with their ages, the ration fed, the type of bedding or amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis service is offered through the Department of Land Resource Science, University of Guelph. Sample containers are available at County and District OMAF offices.

SEWAGE SLUDGE

Sewage sludge is a useful source of nitrogen, phosphorus and organic matter, provided it is low in heavy metals and applied under approved conditions. Consult OMAF Factsheet 100/541, *How and When to Use Sewage Sludge in Crop Production.*

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most field crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. Table shows the pH values below which lime is recommended and the target soil pH to which soils should be limed, for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

Table 76. Soil pH at Which Lime is Recommended for Ontario Field Crops

Crops	Soil pH Below Which Lime is Recommended	Target Soil pH*
Coarse and Medium Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
Perennial legumes, oats, barley, wheat, triticale, beans, peas, canola, flax	6.1	6.5
Corn, soybeans, rye, grass hay, pasture and tobacco	5.6	6.0
Fine Textured Mineral Soils (clays and clay loams)		
Alfalfa	6.1	6.5
Other perennial legumes, oats, barley, wheat, triticale, soybeans, beans, peas, canola, flax	5.6	6.0
Corn, rye, grass hay pasture and tobacco	5.1	5.5
Organic soils (peats and mucks)		
All field crops	5.1	5.5

* *Where a crop is grown in rotation with other crops requiring a higher pH (for example corn in rotation with wheat or alfalfa) it is recommended that the soil be limed to the higher pH.*

Table 77. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH.

Buffer pH	Target soil pH = 6.5 pH below 6.1	Target soil pH = 6.0 pH below 5.6	Target soil pH = 5.5 pH below 5.1
Ground limestone required - t/ha (Based on an Agricultural Index of 75)			
7.0	2	0	0
6.9	2	0	0
6.8	2	0	0
6.7	2	2	0
6.6	3	2	0
6.5	3	2	0
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

The Buffer pH

Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) the accompanying table may be used to determine the amount of lime required to reach different "target" soil pH values required for different crops.

Limestone Quality

Calcitic limestone consists largely of calcium carbonate, and dolomitic limestone is a mixture of both calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent and inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "nuetralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone and, hence, it neutralizes acidity much more slowly; so slowly that it is of little value. The calculation of a fineness rating for ground limestone is illustrated in Table 78.

Table 78. Example Calculation of the Fineness Rating of a Limestone

Particle Size	% of Sample	Effectiveness Factor	
Coarser than no. 10 sieve[1]	10	x 0 =	0
no. 10 to no. 60 sieve	40	x 0.4 =	16
Passing through no. 60 sieve	50	x 1.0 =	50
Fineness Rating		=	66

[1] *A no. 10 Tyler sieve has wires spaced 2.0 mm, and a no. 60 Tyler sieve has wires spaced 0.25 mm apart.*

The Agricultural Index

Some means of combining the Neutralizing Value and the Fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index."

$$\text{The Agricultural Index} = \frac{\text{neutralizing value x fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the OMAF soil test service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\begin{array}{c} \text{Limestone} \\ \text{application} \\ \text{rate from soil} \\ \text{test} \end{array} \times \frac{75}{\begin{array}{c}\text{Agr. Index}\\ \text{of your limestone}\end{array}} = \begin{array}{c} \text{rate of} \\ \text{application} \\ \text{of your limestone} \end{array}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 75/90 x 9 = 7.5 t/ha.

Tillage Depth

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils it should be incorporated to 15 cm depth where practical.

Lowering Soil pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate, but this is not advisable for crops as it only hastens the time when lime will be required. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is below 6.0, the most effective and inexpensive means of supplying magnesium is by application of dolomitic lime. If the pH is above 6.0, and the soil test 20 or below, magnesium can be supplied by either magnesium sulfate or sulfate of potash magnesia, which is a mixture of sulfate of potash and magnesium sulfate. Apply 30 kg/ha of actual soluble magnesium. These latter sources of magnesium are usually quite expensive.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low magnesium soils.

Crops grown on a number of Ontario soils are low in magnesium to an extent that livestock health is affected although the crops themselves do not suffer from magnesium deficiency. In these situations it is usually much less costly to add magnesium to the animal's diet than to add it to the soil. Soil potassium should be closely monitored, however, and potash applications restricted to requirements as measured by soil test.

FERTILIZER MATERIALS

Nitrogen fertilizer materials are available in dry or liquid forms. Although there are some limitations to use of these materials (see section, *Toxicity of Fertilizer Materials),* in most cases the different sources will produce equal yields. The farmer's choice of material should therefore depend on availability, equipment for handling, and cost per kilogram of nitrogen, plus the cost of application.

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[1] *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

Table 79. Fertilizer Materials - Primary Nutrients

Nitrogen Materials	Form	% Nitrogen (N)
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[1]	20
Ammonium nitrate-urea	Liquid	28
Ammonium nitrate-urea	Liquid	32
Ammonia ammonium nitrate-urea	Liquid[1]	41
Ammonia-ammonium nitrate	Liquid[1]	41
Anhydrous ammonia	Liquid[1]	82

Phosphate Materials	% Phosphate (P_2O_5)
Single superphosphate	20
Triple superphosphate	44 to 46
Monoammonium phosphate	48 to 52
Diammonium phosphate (18-46-0)	46

Potash Materials	% Potash (K_2O)
Muriate of potash	60 to 62
Sulfate of potash	50
Sulfate of potash magnesia (11% Mg)	22
Potassium nitrate (13-0-44)	44

[1] *Liquid under pressure.*

Fertilizer Materials - Secondary and Micronutrients

If secondary or micronutrients are proven to be needed (by soil and/or tissue tests) then the most common sources of these are:

Magnesium (Mg)

Dolomitic Limestone	6-13% Mg
Epsom Salts (Magnesium sulphate)	10.5% Mg
Sulphate of Potash Magnesia	11% Mg

Boron (B)

Various boron sources are available	8-21% B

Copper (Cu)

Copper Sulphate	13-25% Cu
Copper Chelates	5-13% Cu

Manganese (Mn)

Manganese Sulphate	26-28% Mn
Manganese Oxysulphate	28% Mn
Manganese Chelates	5-12% Mn

Molybdenum (Mo)

Sodium Molybdate	39% Mo

Zinc (Zn)

Zinc Sulphate	36% Zn
Zinc Chelates	7-14% Zn
Zinc Oxysulphate	18-36% Zn

Various fertilizer companies have available, in addition to the above micronutrient sources, premixes containing one or more of the above micronutrients.

Individual Factsheets are available on some of these micronutrietns. For a list of these see Publications section.

A farmer should first calculate the cost per kilogram of nitrogen for various sources delivered to his farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. The following tables show the percentage of fertilizer nutrient contained in different materials.

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient, (2) differences in solubility of the salts in the soil, and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia and boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in soil solution at any one time is very low.

Nitrogen Fertilizers

Ammonium nitrate, monoammonium phosphate and ammonium sulphate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea. Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

Because anhydrous ammonia and aqua ammonia are extremely toxic fertilizers, they should not be placed near seeds. It is preferable to make pre-plant applications crossways to the direction in which the crop will be planted.

Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

Phosphate Fertilizers

Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of field crops.

Diammonium phosphate is more toxic than other phosphate fertilizer - see above under nitrogen fertilizers.

Potash Fertilizers

Muriate of potash (KCl) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

Sulphate of potash (K_2SO_4) is less toxic than muriate of potash.

Sulphate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

Potassium nitrate is one of the safer sources of potassium.

Fertilizers Containing Micronutrients

Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients and maximum safe rates should be reduced. Boron is particularly toxic, and should be applied with caution particularly when banded.

Table 80. Maximum Safe Rates of Nutrients

SPRING OATS AND BARLEY (fertilizer with the seed)	
Sands and Sandy Loam Soils	35 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 20 kg nitrogen or 35 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
Loams, Silt or Clay Loams	45 kg nitrogen or 70 kg(nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 30 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If urea is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
WINTER WHEAT, TRITICALE OR BARLEY (fertilizer with the seed)	
All Soils	15 kg nitrogen or 30 kg (nitrogen + potash) per hectare. **Diammonium phosphate** (18-46-0) or **urea** should not be drilled with the seed of fall-seeded cereals[1].
CORN (fertilizer with the seed)	
All Soils	7 kg (nitrogen + potash) per hectare in one metre rows. **Diammonium phosphate** or **urea** should not be applied with the seed of corn. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 x 7 = 14 kg (nitrogen + potash) per hectare).
CORN (fertilizer banded 5 cm to the side and 5 cm below the seed)	
All Soils	55 kg nitrogen or 90 kg (nitrogen + potash) per hectare. If **urea** is the N source, 30 kg nitrogen or 60 kg (nitrogen + potash) per hectare. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 x 55 = 110 kg N per hectare).
FLAX AND CANOLA (no fertilizer with seed)	
All soils	Rates recommended are normally safe when broadcast.
PEAS, BEANS AND SOYBEANS (no fertilizer with seed)	
All soils	**(fertilizer banded 5 cm to the side and 5 cm below the seed)** 30 kg nitrogen or 90 kg (nitrogen + potash) per hectare. Rates recommended are normally safe when broadcast.

[1] *Fertilizers containing more than half as much nitrogen as phosphate (e.g. 16-16-16) frequently contain urea. Note that fertilizers containing urea are not suitable for banding at seeding in many cases.*

Guidelines for Safe Rates of Nutrients Applied at Seeding

Fertilizer toxicity varies widely, depending on the amount of soil moisture. To insure completely safe rates of banded fertilizer for all seeding conditions would require extremely low rates of application. The maximum safe rates suggested here will probably reduce or delay germination, or retard growth in up to 10% of the cases where they are used. In most cases, it is advisable to use lower rates of fertilizer at seeding than those listed in the following table. If fertilizer requirements are high, it may be better to broadcast most of the fertilizer required and to band only a small portion at seeding. Fertilizers containing the micronutrients boron, copper, iron, manganese and zinc are more toxic, and the safe rates recommended will be lower than those shown in this table.

GENERAL INFORMATION ON PESTICIDE USAGE

Brands of a pesticide from different companies often have different concentrations of the same chemical in them. Consequently, if you use one with a concentration different from that listed in the recommendations in this publication, you will need to adjust the rate of application so that you will be applying the same amount of actual chemical (active ingredient).

PRECAUTIONS WITH ALL PESTICIDES

Read the following points before using any pesticides:

1. Always read the label before opening pesticide containers and follow all precautions and directions.
2. Never smoke, chew tobacco, or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle the concentrate, and when coming in contact with dilute spray i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.
4. Inhalation of spray droplets, dust or fumes should be avoided. Wear a respirator to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. For gases, a self-contained breathing apparatus may be required.
5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots. Avoid spilling pesticides on skin or clothing.
6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing out spray equipment. Never fill a sprayer directly from a stream, pond or well, unless the unit is equipped with an anti-backflow device to prevent siphoning.
7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident. You can use this book, see Table 82 and 83.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including underclothes immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.
2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove all contaminated clothes, including underclothes, have a bath or shower and put on freshly laundered clothing.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common name chemicals with you to the hospital (See Emergency Procedures for Pesticide Poisoning).
4. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice. (See list page 69).
5. If a well becomes contaminated, follow clean-up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted:

Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone (416) 965-3610.

During weekends, public holidays and non-office hours, telephone (416) 965-1211 and ask for the "on-call" physician.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled onto clothing or parts of the body remove clothing including under-garments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from the list mentioned above or use this book for reference.

RELATIVE HAZARDS TO MAN FROM INSECTICIDES

Extreme Hazard

Counter (terbufos)
Dasanit (fensulfothion)
Di-Syston (disulfoton)
Dyfonate (fonofos)
Furadan (carbofuran)
Guthion (azinphos-methyl)
Lannate (methomyl)
Thimet (phorate)

These pesticides are dangerous through inhalation, skin contact, or if taken by mouth. A few grams can be fatal. Wear protective clothing (see Precautions with Pesticides), avoid mixing in windy areas, dispose of containers properly (see Precautions with Pesticides) and always wash and change clothing immediately after use.

Moderate Hazard

Ambush (permethrin)
Basudin (diazinon)
Captan* (captan)
Cygon (dimethoate)
Imidan (phosmet)
Lorsban (chlorpyrifos)
Thiodan (endosulfan)

These pesticides are dangerous if handled carelessly. Caution is required to ensure that they are not taken internally or allowed to contact bare skin. Wear protective clothing including respirator and goggles when mixing or working with them. Avoid breathing the vapors. Wash and remove clothing after applying these materials. Triple rinse and dispose of containers properly (see Precautions with Pesticides).

* Current studies indicate that captan requires special handling procedures as outlined on the label. Therefore follow directions closely.

Low Hazard

Pesticides listed in this publication and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely by following all directions and precautions for proper use as listed on the product label.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should be commenced prior to using these pesticides and not after applications have commenced because the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are: Basudin (diazinon), Counter (terbufos), Cygon (dimethoate), Dasanit (fensulfothion), Di-syston (disulfoton), Dyfonate (fonofos), Furadan (carbofuran), Guthion (azinphos-methyl), Imidan (phosmet), Lannate (methomyl), Lorsban (chlorpyrifos), and Thimet (phorate).

PROTECTIVE CLOTHING WHEN USING PESTICIDES OUTDOORS

1. It is recommended that neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields be worn to reduce the risk of dermal exposure when measuring, mixing and loading pesticides.

   Protective clothing, including disposable gloves, aprons or coveralls and hat covers, are available at reasonable prices from the major safety supply companies listed below.

2. Wash all clothing after use. Wear freshly laundered clothes each day.
3. Although recommended when loading and handling concentrates, the wearing of dual cartridge chemical respirators is neither mandatory nor required with all pesticides or under all conditions of pesiticide use. If a label specifies respiratory protection, follow the directions closely. A wide range of respiratory devices for outdoor respiratory protection from certain pesticides is available from the major safety supply companies who offer both full and half-face models in varying sizes. Consult the safety supply company of your choice for appropriate guidance and selection.

Table 81. Safety Supply Companies in Ontario Providing Protective Clothing and/or Respiratory Devices for Outdoor Protection Against Certain Pesticides.

Respiratory Devices Manufactured By	Available From
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 60 Mobile Drive, Toronto, M4A 2R7, Tel. (416) 752-8780 Branches: Hamilton & Belleville
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catherines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Kasco Helmets	The St. George Co., St. George, N0E 1N0. Tel. (519) 442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York, M3N 1X8, Tel. (416)667-9400
3M Occupational Health & Safety Products Div.	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
North	Siebe-North Inc., 26 Dansk Court, Rexdale, M9W 5V8, Tel. (416) 675-2790
Racal Airstream	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.

(Continued on Page 60)

Table 81 (Cont'd)

Respiratory Devices Manufactured by	Available From
Safety House	Safety House of Canada Ltd., 1275 Castlefield Ave., Toronto, M6B 1G4, Tel. (416) 789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines & Stoney Creek.
Scott	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416) 425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Willson	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8, Tel. (416) 364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

REENTRY INTO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended.

24 Hours	48 Hours
Lannate (Methomyl)	Guthion (Azinphos-methyl) Furadan (Carbofuran)

STORAGE

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage:

   Schedule 1, 2 and 5-pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING - AUTHORIZED PERSONNEL ONLY" in black capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers. See also OMAF Factsheet Agdex 607, *Farm Storage of Pesticides.*

DISPOSAL OF PESTICIDE CONTAINERS & CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or public outdoor areas.

2. Un-rinsed containers can contain as much as 3% of the original formulations. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful - why not use that 3% to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the container directly into the spray tank. This procedure takes less than a minute and results in a rinsed container. The rinsed containers should be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

SPRAYERS

Herbicide sprayers, capable of delivering sufficient litres per hectare for adequate coverage, are satisfactory for applying emulsion-type insecticides. However, if 2,4-D or related herbicides have been used in them, such sprayers will have to be cleaned thoroughly or foliage is apt to be damaged. The detergent recommended should contain ammonia for best results.

For applying the wettable powder formulations, a high-capacity (450 L/ha), high-pressure piston pump sprayer with an agitator, is recommended. Keep in mind that the higher the pressure the greater the danger of drift to other crops.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual speed and pressure.

For information on calibration, see the current OMAF Publication 75, *Guide to Chemical Weed Control.*

APPLICATION BY AIRPLANES OR HELICOPTERS

Aerial applicators must be licensed by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides, and Schedule 2 hormone-type herbicides. The area will be inspected by ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

1. correct calibration and maintenance of spray equipment;
2. correct operation of the equipment;
3. being aware of the toxicity of the pesticide in use; and
4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift*, Agdex 607, or Canadex 607, *Pesticides: Effects of Drift and Droplet Size.*

PROTECT HONEYBEES

Because bees may be killed, do not apply insecticides that are toxic to bees (see list and remarks, in Table 8.3) on crops or wild plants that are in bloom. Sevin (carbaryl) is extremely toxic to honeybees. If insect control is necessary while crops are in bloom or corn is shedding pollen, spray only in the evening or in the early morning when bees are not in the field. Do not spray when the wind will carry the insecticide to adjacent bee pastures or into the general area of apiaries.

WHEN PLANNING TO APPLY A PESTICIDE, ADVISE LOCAL BEEKEEPERS SO THEY HAVE AN OPPORTUNITY TO MOVE COLONIES OUT OF THE DANGER AREA. YOUR LOCAL AGRICULTURAL REPRESENTATIVE HAS A LISTING OF THE BEEKEEPERS IN YOUR AREA.

SEED TREATMENTS

Seed dressings or treatments are poisonous to man and livestock. Do not inhale the fumes or dust when treating or handling treated seed. Wash all residues of these chemicals from the skin after seed treatment is completed. Chemically treated seed is poisonous. Never feed surplus seed to livestock. Destroy all bags that have held treated seed as recommended in the container disposal section above.

RESIDUES ON CROPS TO BE HARVESTED, FED OR GRAZED

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with persistent residues are fed to livestock the poisons tend to accumulate in the body fat and milking cows will excrete them, or their metabolic products in the milk. Young calves, heifers, and dry cows will store these in body fat and secrete them when they freshen months later. Do not use residues from Thiodan-treated crops for bedding. To avoid residue problems, use (1) the proper chemical, (2) the recommended dosage, and (3) observe the proper interval to harvest.

FORMULATIONS

Pesticides may be in either liquid or solid form.

Liquids	E or EC	- Emulsifiable Concentrate
	F	- Flowable
	L	- Liquid
	LC	- Liquid Concentrate
	S	- Sprayable
	SC	- Sprayable Concentrate
	Su	- Suspension
Solids	G	- Granular
	P	- Powder
	SP	- Soluble Powder
	WP	- Wettable Powder

Table 82. Fungicides for Field Crops

Trade Name	Active Ingredient	Formulation[1]	Ontario Schedule[2]
SEED TREATMENTS			
Fungicides			
Agrox N-M	maneb	P-DB	3
Agrox flowable	maneb	S	3
Anchor	carbathiin + thiram	S	2
Busan 30	TCMTB	EC	2
Captan Flowable	captan	S	2
Captan 30 -	captan	S	2
Co-op N-M	maneb	P-DB	3
Polyram Liquid	metiram	S	3
Polyram 7	metiram	P-DB	3
Vitaflo-250	carbathiin	S	3
Vitaflo-280	carbathiin + thiram	S	3
Vitavax Powder	carbathiin + thiram	P-DB	2
Fungicides with Insecticides			
Agrox D-L Plus	diazinon + lindane + captan	P-DB	2
Co-op D-L+C	diazinon + lindane + captan	P-DB	2
Pfizer D-L-C	diazinon + lindane + captan	P-DB	2
B-3 (D-L-C)	diazinon + lindane + captan	P-DB	2
Captan-methoxychlor	captan + methoxychlor	S	2
Co-op N-M Dual Purpose	maneb + lindane	P-DB	3
DCT	diazinon + captan + thiophanate-methyl	P-DB	3
Drillbox Lindasan	captan + lindane	P-DB	2
Gammasan	captan + lindane	S	2
Mergamma N-M	maneb + lindane	P-DB	2
Methoxychlor 3 (flowable)	captan + methoxychlor	S	2
Polyram-Diazinon	diazinon + metiram	P	3
Vitaflo Dual Purpose	carbathiin + thiram + lindane	S	2
Vitavax Dual Powder	carbathiin + thiram + lindane	P-DB	2
Vitavax RS Flowable	carbathiin + thiram + lindane	P-DB	3
FOLIAR SPRAYS - Fungicides			
Benlate 50 W	benomyl	WP	3
Botran 75 W	dichloran	WP	3
Rovral 50 W	iprodione	WP	3
Easout 70 W	thiophanate-methyl	WP	3

[1] EC (Emulsifiable Concentrate); P-DB (Powder Drill Box); S (Flowable Suspension); WP (Wettable Powder)

[2] The numbers within the brackets ( ) identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act.

Explanation of Schedules.

Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application on agricultural land.
Schedule 6	Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you.

Table 83. Insecticide Notes

Trade Name (active ingredient)	Insecticide Classification	Formulation	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
**Ambush (permethrin)	pyrethroid	500 EC	Not after 5-leaf stage	Moderately toxic	No	Chipman UCO	Corn	(3)
Basudin (diazinon)	organo phosphorus	50 W	7	Moderately toxic	Yes	Chipman Ciba-Geigy Niagara Pfizer Sanex	Alfalfa, corn, field beans, peas. Toxic to bees.	(2)
Counter (terbufos)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Pfizer	Corn	(5)
Cygon (dimethoate)	organo phosphorus	480 E	2 Alfalfa 7 Beans	Moderately toxic	Yes	Bartlett Chipman Niagara Pfizer, UCO Sanex	Alfalfa, field beans. Toxic to bees.	(2)
Dasanit (fensulfothion)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Ciba-Geigy Niagara Pfizer, UCO	Corn	(2)
**Decis (deltamethrin)	pyrethroid	2.5 EC	14	Moderately toxic	No	Pfizer Niagara	Canola	(2)
Di-Syston (disulfoton)	organo phosphorus	15 G 720 LC	planting time only	Extremely toxic	No	Niagara Pfizer	Corn	(5)
Dyfonate (fonofos)	organo phosphorus	20 G	planting time only	Extremely toxic	No	Chipman UCO	Corn	(5)
Dylox (trichlorfon)	organo phosphorus	80% SP 420 Liquid	21	Lower toxicity	Yes	Agrospray Niagara Sanex UCO	Cereals. Relatively safe to bees.	(3)
Furadan (carbofuran)	carbamate	10 G CR-10 G 480 F	planting time only 7	Extremely toxic	Yes, Permit Required	Bartlett King Agro Niagara UCO	Corn, alfalfa. Toxic to bees.	(2), (Granular). (5), (Flowable).
Guthion (azinphos-methyl)	organo phosphorus	240 SC	3 Beans 21 Alfalfa 30 Grain	Extremely toxic	Yes, Permit Required	Bartlett Chipman Niagara Pfizer Sanex	Field beans, soybeans. Toxic to bees.	(5)
Imidan (phosmet)	organo phosphorus	50 W	7	Moderately toxic	Yes	Chipman	Alfalfa. Toxic to bees.	(3)
Lannate (methomyl)	carbamate	L	21	Extremely toxic	Yes	Pfizer Niagara	Grain	(2)
**Lorsban (chlorypyrifos)	organo phosphorus	4 E 15 G	70	Moderately toxic	Yes Permit Required	Pfizer King Agro	Corn, canola, cereals Corn	(3)
Malathion	organo phosphorus	500 EC 25 W	7	Lower toxicity	Yes	Bartlett Chipman Niagara Pfizer Sanex UCO	Alfalfa, grain crops, field beans soybeans. Toxic to bees. Less effective below 16°C	(3)

*** See "Temporary Registration of Pesticides" inside front cover.*

Table 83. Insecticide Notes (Cont'd)

Trade Name (active ingredient)	Insecticide Classification	Formulation	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks	Ontario Schedule[2]
Methoxychlor	organo chlorine	240 EC 50 W	7	Lower toxicity	Yes	Bartlett Chipman Niagara Sanex UCO	Alfalfa, grain crops. Relatively safe to bees.	(3)
**Ripcord (cypermethrin)	pyrethroid	400 EC	30	Moderately toxic	No	Ciba-Geigy	Canola	(2)
Sevin (carbaryl)	carbamate	480 Su	1 Corn 3 Peas 14 Grain 1 Alfalfa 1 Beans	Lower toxicity	Yes	Bartlett Chipman Niagara Pfizer UCO	Alfalfa, corn, field beans, soybeans, grain crops. Extremely toxic to bees.	(3)
Thimet (phorate)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Pfizer UCO	Corn	(2)
Thiodan (endosulfan)	organo chlorine	4 EC	2	Moderately toxic	Yes	Chipman Niagara Pfizer Sanex	Field beans, soybeans. Toxic to bees.	(2)
**Thuricide, Dipel (Bacillus thuringiensis)	Biological	HPC SC	0	Lower toxicity	Yes	Chipman Niagara		(3)

[1] *See Pesticides Section, Relative Hazards to Man from Insecticides*

[2] The numbers within the brackets () identify the Schedules in which the TRADE NAME products listed in this Table are classified under the Pesticides Act.

Explanation of Schedules.

Schedule 1	Restricted. Use permit only.
Schedule 2	Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3	May be available for "Domestic" purposes if so registered.
Schedule 4	"Domestic" products only.
Schedule 5	Limited to application on agricultural land.
Schedule 6	Similar to schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you.

** *See "Temporary Registration of Pesticides" inside front cover.*

Table 84. The Addresses and Phone Numbers of Companies Supplying Insecticides

Distributor	Address	Phone
Agrospray	P.O. Box 130, 40 Cedar St. Tillsonburg, Ont. N4G 4H3	(519) 842-8408
Bartlett	P.O. Box 490, 931 Bartlett Rd. Beamsville, Ont. L0R 1B0	(416) 563-8261
Chipman	P.O. Box 9910 Stoney Creek, Ont. L8G 3Z1	(416) 643-4123
Ciba-Geigy	6860 Century Ave. Mississauga, Ont. L5N 2W5	(416) 821-4420
King Agro Inc.	P.O. Box 1088, Chatham, Ont. N7M 5L6	(519) 354-3210
Niagara	1274 Plains Rd. E., Burlington, Ont. L7S 1W6	(416) 634-2355
Pfizer	1 Wilton Grove Rd., P.O. Box 2005, London, Ont. N6A 4C6	(519) 681-2173
Sanex	2695 Slough St. Mississauga, Ont. L4T 1G2	(416) 677-4820
UCO	P.O. Box 527, Station A Mississauga, Ont. L5A 3A1	(416) 270-3560

GENERAL INFORMATION

SEEDING RATES

Crop	kg/ha	
Wheat(Winter & Spring)	100-130	
Oats	55-110	not seeded down
	40- 55	seeded down
Barley (Winter & Spring)	80-160	
Rye	70- 95	small seeded varieties
	120-160	large seeded varieties
Triticale (OAC Wintri)	75-100	
Corn	11- 22	
Beans (White)	40- 45	
Soybeans	65-100	
Peas (Field)	130-200	
Buckwheat	55	
Flax (for seed)	40	
Canola	5.5-8	
Sunflower	6-8	
Mustard	8-11	
Turnips	0.6	
Rape (forage)	1.75	in rows
Kale	2.25	in rows
	7	broadcast
Sorghum-sudan grass	13-17	

SEEDS PER UNIT OF FORAGE SPECIES

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's-foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Bromegrass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Western Ontario Offices

County	OMAF Offices		Field Crops Specialists	
Essex	46 Fox St., Essex N8M 2S2	519-776-7361	Henry Olechowski c/o RCAT, Ridgetown N0P 2C0	519-674-5456
Kent	Box 726, 435 Grand Ave. W. Chatham N7M 5L1	519-354-2150		
Lambton	Box 730, Petrolia N0N 1R0	519-882-0180	John Schleihauf 367 Ridout St., London N6A 2P2	519-434-6811
Middlesex	50 King St., London N6A 2P2	519-434-6811		
Oxford	Box 666, Woodstock N4S 7Z5	519-537-6621	Hugh Martin 594 Talbot St., St. Thomas N5P 1C7	519-631-4700
Elgin	594 Talbot St., St. Thomas N5P 1C7	519-631-4700		
Norfolk	Box 587, Simcoe N3Y 4N5	519-426-7120	Bruce Archibald Box 587, Simcoe N3Y 4N5	519-426-7120
Brant	207 Greenwich St., Brantford N3S 2X7	519-759-4190		
Haldimand	Box 129, Cayuga N0A 1E0	416-772-3381		
Huron	Box 159, Clinton N0M 1L0	519-482-3428	John Heard Box 398 413 Hibernia St., Stratford N5A 6T3	519-271-0280
Perth	Box 398, 413 Hibernia St. Stratford N5A 6T3	519-271-0280		
Wentworth	RR 1, Ancaster L9G 3K9	416-527-2995	Jerry Winnicki R.R. 1, Ancaster L9G 3K9	416-527-2995
Niagara, North	Vineland Station L0R 2E0	416-562-4142		
Niagara, South	574 South Pelham St., Welland L3C 3C6	416-732-7552		
Wellington	Box 159, Fergus N1M 2W7	519-846-5371	Harvey Wright c/o Crop Science University of Guelph, Guelph N1G 2W1	519-824-4120 Ext. 2513
Waterloo	279 Weber St. N., Waterloo N2J 3H8	519-884-5390		
Halton	17 Wilson Dr., Milton L9T 3J7	416-878-2314		
Bruce	Box 1330, Walkerton N0G 2V0	519-881-3301	Joan McKinlay Box 1330, Walkerton N0G 2V0	519-881-3301
Grey	181 Toronto St. S., Markdale N0C 1H0	519-986-2040		
Dufferin	R.R. 4, Orangeville L9W 2Z1	519-941-3830		
Simcoe, North	Box 340, Elmvale L0L 1P0	705-322-2231	Dave Morris Box 370, Alliston L0M 1A0	705-435-5521
Simcoe, South	Box 370, Alliston L0M 1A0	705-435-5521		
Peel	3 Elizabeth St. S. Brampton L6Y 1P7	416-451-5474		
York	Newmarket Plaza, Newmarket L3Y 1N1	416-895-4519		

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Eastern Ontario Offices

County	OMAF Offices		Field Crops Specialists	
Ontario	Box 309, Uxbridge L0C 1K0	416-852-3328	Jack Kyle 322 Kent St. W., Lindsay K9V 2Z9	705-324-6125
Victoria	322 Kent St. W., Lindsay K9V 2Z9	705-324-6125		
Durham	234 King St. E., Bowmanville L1C 1P5	416-623-3348		
Peterborough	55 George St. N. Peterborough K9J 3G2	705-745-2403		
Northumberland	Box 820, Brighton K0K 1H0	613-475-1630	John Nederend Box 470, Picton K0K 2T0	613-476-3224
Hastings	Box 340, Stirling K0K 3E0	613-395-3393		
Lennox & Addington	41 Dundas St. W., Napanee K7R 1Z5	613-354-3371		
Prince Edward	Box 470, Picton K0K 2T0	613-476-3224		
Frontenac	Box 651, 1055 Princess St. Kingston K7L 1H3	613-544-1995		
Leeds	Box 635, Brockville K6V 5V8	613-342-2124	Gilles Quesnel Box 2004, Kemptville K0G 1J0	613-258-3411
Grenville	Box 2004, Kemptville K0G 1J0	613-258-3411		
Dundas	Box 488, Winchester K0C 2K0	613-744-2313		
Stormont	Box 655, 109-11st St. W. Cornwall K6H 5T3	613-933-1581		
Lanark	P.O. Box 37, Perth K7H 3E2	613-267-4200	Dorothy Haley 26 Thorncliff Place Nepean K2H 6L2	613-828-9167
Renfew	315 Raglan St. S., Renfrew K7V 1R6	613-432-4841		
Carleton	26 Thorncliff Place, Nepean K2H 6L2	613-828-9167		
Prescott	Box 110, Plantagenet K0B 1L0	613-673-5115	Paul Beaudin Box 110 Plantagenet K0B 1L0	613-673-5115
Russell	Box 540, 666 Notre Dame St. Embrun K0A 1W0	613-443-3391		
Glengarry	Box 579, Alexandria K0C 1A0	613-525-1046		

Northern Ontario District Offices

District	OMAF Offices		Field Crops Specialists	
Algoma	1496 Wellington St. E. Sault Ste. Marie P6A 2R1	705-253-1161	222 McIntyre St. W. North Bay P1B 2Y8	705-474-3050
Cochrane, N.	Experimental Farm Kapuskasing P5N 2X9	705-335-5828		
Cochrane, S	Box 608, Matheson P0K 1N0	705-273-2509		
Kenora	Ontario Government Building Box 3000, Dryden P8N 3B3	807-223-2415		
Manitoulin	Box 328, Gore Bay P0P 1H0	705-282-2043		
Muskoka & Parry Sound	Box 130, Huntsville P0A 1K0	705-789-5491		
Nipissing	222 MCIntyre St. W., North Bay P1B 2Y8	705-474-3050		
Rainy River	Front St., Emo P0W 1E0	807-482-2310		
Sudbury	1414 LaSalle Blvd., Sudbury P3A 1Z0	705-566-1630		
Timiskaming	Box "G," New Liskeard P0J 1P0	705-647-6701		
Thunder Bay	Ontario Government Building 435 James St. S. Thunder Bay P7E 6E3	807-475-1631		

ONTARIO MINISTRY OF AGRICULTURE AND FOOD

Tobacco Specialists

	Milt Watson, Norm Sheidow	Research Station, Box 186, Delhi, N4B 2W9 519-582-1950

Pasture Specialist

	Susan Robinson, c/o Crop Science, University of Guelph, Guelph N1G 2W1 519-824-4120, Ext. 2513

Seeds and Weeds Specialists

Southern Ontario	R.D. McLaren, c/o Crop Science, University of Guelph, Guelph N1G 2W1 519-824-4120, Ext. 2513
Northern Ontario	222 McIntyre St. W., North Bay P1B 2Y8 705-474-3050

Insect and Disease Specialists

Insects	Karl Bereza, R.R. 1, Ancaster L9G 3K9 416-527-2995
Diseases	Craig Hunter, Research Station, P.O. Box 587, Simcoe N3Y 4N5 519-426-7120
Insects & Diseases	Henriette Plas, c/o Crop Science, University of Guelph, Guelph N1G 2W1 519-824-4120, Ext. 2513

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Bishop Farm Seeds Ltd. Box 338, Belleville, Ontario K8N 5A5	613-968-5533
Dekalb Canada Inc. Box 430, Chatham, Ontario N7M 5K5	519-352-5310
Funk Seeds Box 29, Hyde Park, Ontario N0M 1Z0	519-473-2651
General Seed Co. Box 5021, Hamilton, Ontario L8S 4K9	416-648-6900
Jacques Canada Ltd. Box 100, Emeryville, Ontario N0R 1C0	519-727-6046
King Agro Inc. P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Labonté Seeds Ltd. Box 1660, New Liskeard, Ontario P0J 1P0	705-647-6821
Maple Leaf Mills Limited P.O. Box 9, Wallaceburg, Ontario N8A 4L5	519-627-1428
Mapleseed Inc. Oakwood, Ontario K0M 2M0	705-786-2020
Northrup King Seeds Ltd. 1250 Franklin Blvd., Box 1207 Cambridge, Ontario N1R 6C9	519-621-0890
Oseco Inc. P.O. Box 219, Brampton, Ontario L6V 2L2	416-846-5080
Oseco Farm Seed Centre 75 Cardigan Street, Guelph, Ont. N1H 3Z7	519-822-4800
Otto Pick & Sons Seeds Ltd. Box 126, Richmond Hill, Ontario L4C 4X9	416-884-1147
PAG Seeds Box 490, Princeton, Ontario N0J 1V0	519-458-4336
Pioneer Hi-Bred Ltd. Box 730, Chatham, Ontario N7M 5L1	519-352-6350
Rothwell Seeds Ltd. Box 511, Lindsay, Ontario K9V 4L9	705-324-9591
SeCan Association* Suite 512, 885 Meadowlands Dr. Ottawa, Ontario K2C 3N2	613-225-6891
Speare Seeds Ltd. P.O. Box 171, Harriston, Ontario N0G 1Z0	519-338-3840
Tib Szego Associates Ltd. P.O. Box 366, Lindsay, Ontario K9V 4S3	705-324-0042
United Cooperatives of Ontario 151 City Centre Drive Mississauga, Ontario L5A 3A4	416-270-3560
W. G. Thompson & Sons Ltd. Box 250, Blenheim, Ontario N0P 1A0	519-676-5411

**SeCan is an association of seed growers and seed companies which handles the release and promotion of publicly developed varieties. For more information on these varieties, contact your local SeCan member.*

ONTARIO MINISTRY OF THE ENVIRONMENT – PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Southwestern Region Elgin, Middlesex, Oxford	D.C. Morrow & W. Lampman 985 Adelaide Street South, London N6E 1V3	519-661-2200
Essex, Kent, Lambton	H.E. Collins P.O. Box726, 435 Grand Ave. W. Chatham N7M 5L1	519-354-2150
Bruce Grey, Huron, Perth	B.T. Lobb 20 King Street, P.O. Box 688, Ont. Ministry of Agr. & Food Bldg. Clinton N0M 1L0	519-482-3248
West Central Region		
Haldimand, Norfolk, Niagara, Hamilton, Wentworth	J. Percy Ont. Gov't Bldg. 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Dufferin, Wellington, Waterloo, Brant	R. Miller Ont. Gov't. Bldg., 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill & D. Trenholm 7 Overlea Blvd., Don Mills M4H 1A8	416-424-3000 (ext. 211)
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George Street N., Peterborough K9J 3G6	705-743-2972
Simcoe, Muskoka	W. Cowie 12 Fairview Road, Barrie L4N 4P3	705-726-1730
Souteastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon 133 Dalton St., Kingston K7L 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett Northgate Shopping Centre, 1500 Fisher St. North Bay P1B 2H3	705-476-1001
Cochrane, Timiskaming, Algoma	P. McCubbin 199 Larch St., Sudbury P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Building, 435 James St. S., Thunder Bay P7C 5G6	807-475-1215
Head Office		
	Agricultural and Industrial Chemicals Section 135 St. Clair Avenue W., Suite 100 Toronto, Ontario M4V 1M2	416-965-2401

PUBLICATIONS – The following publications are available from any of the Pesticide Control Field offices or from the Head Office of the Ministry of the Environment

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical-Storage Signs

PUBLICATIONS

Available from your local office of the Ontario Ministry of Agriculture and Food

CORN

Corn Production in Ontario – Publication 13
1986 Ontario Hybrid Corn Performance Trials Report

Factsheets:

111/25	*Corn Lodging*
111/31	*Heat Units for Corn in Southern Ontario*
111/61	*High Moisture Corn*
100/531	*Zinc Requirements for Field Crops*
111/541	*Nitrogen Recommendations for Corn*
111/542	*Nitrogen Fertilizer Materials*
111/622	*European Corn Borer*
111/622	*Corn Leaf Aphid*
111/622	*Corn Rootworms*
111/622	*Potato Stem Borer in Field Corn*
111/630	*Stunting of Young Corn*
111/632	*Heat Smut of Corn*
111/632	*Leaf Diseases of Field Corn*
111/736	*Harvesting and Storing Quality Grain Corn*
111/742	*Calibrating Your Corn Planter*
111/745	*Measuring Corn Harvesting Losses*
111/840	*Pricing Corn in Ontario*
440/60	*Moldy Feeds and Swine Diseases*
675	*Sap Beetles on Raspberries, Tomatoes, Corn*

FORAGES

Alfalfa – Publication 59
Pasture Production – Publication 19
Quality Forage for Milk or Beef – Publication 54
Annuals for Supplementary Feed – Publication 47
Red Clover for Feed, Seed and Soil – Publication 221

Factsheets:

120/22	*Successful Forage Establishment*
120/31	*Selecting a Perennial Forage*
120/52	*Quality Hay Crop Silage*
120/81	*Protein Supplements from Forage Legumes*
120/30	*Fertilizer Use in Forage Establishment*
120/622	*European Skipper*
120/736	*Barn Hay Drying*
120/745	*Haying with a Large Round Baler*
122/21	*Alfalfa Persistence*
121/21	*Establishment of Bird's-Foot Trefoil*
121/21	*Stop Alfalfa Winterkill*
121/531	*Boron Requirements for Alfalfa*
121/542	*Fertilizer Practices for Alfalfa Production*
121/600	*Verticillium Wilt of Alfalfa*
121/622	*Alfalfa Weevil*
121/622	*Early Warning System for Alfalfa Weevil Management*
121/622	*Alfalfa Blotch Leafminer*
121/622	*Potato Leafhopper in Alfalfa*
121/736	*Determining Moisture Content of Alfalfa Using a Microwave Oven*
122	*Producing Red Clover Seed in Ontario*
122/10	*Red Clover in Ontario*
122/20	*Bird's-Foot Trefoil Production*
122/22	*Establishment of Bird's-Foot Trefoil*
460/10	*Hay and Pasture for Horses*

CEREAL GRAINS

Rid Ontario of Common Barberry and European Buckthorn – Publication 49
Insects in Farm Stored Grain – Publication 229
Smut Diseases of Grain Crops – Publication 524
1985 Regional Test Report Barley, Oats, and Wheat, Department of Crop Science, University of Guelph

Factsheets:

100/531	*Manganese in Soybean and Small Grain Production*
110/622	*Armyworms*
110/632	*Cereal Virus Diseases*
110/717	*Grain Aeration*
112/10	*Winter Wheat in Ontario*
112/630	*Root, Crown and Basel Stem Diseases of Winter Wheat*
112/630	*Head Diseases of Winter Wheat*
112/600	*Leaf Diseases of Winter Wheat*
113/632	*Oat-Cyst Nematode*
114/542	*Fertilizing Practices for Growing Barley*
114/632	*Leaf and Head Diseases of Barley*
118/10	*Winter Triticale in Ontario*

FIELD BEANS

Factsheets:

140/630	*Virus Diseases and Bronzing of Field and Snap Beans*
142	*Growing White Beans in Ontario*
142/10	*Kidney Beans in Ontario*
142/622	*White Bean Insects*
142/632	*Common Blight of Field Beans*
255/630	*Fungal Diseases of Field and Snap Beans*

FIELD PEAS

Factsheets:

142/13	*Field (Dry) Peas in Ontario*

SOYBEANS

Soybean Production in Ontario – Publication 173

Factsheets:

100/531	*Manganese in Soybean and Small Grain Production*
141/10	*Getting into Soybeans – Harvesting, Marketing, Storage and Feeding*
141/10	*Getting into Soybeans – Planting and Growing the Crop*
141/745	*Measuring Soybean Harvesting Losses*
141/840	*Pricing and Marketing Soybeans*

FLAX

148/10	*Flax in Ontario*

CANOLA

149/10	*Spring Canola in Ontario*

HERBICIDES AND WEEDS

Guide to Chemical Weed Control – Publication 75
Ontario Weeds – Publication 505 Price $2.50

Factsheets:

744	*Weed Sprayer Calibration*
100/744	*Calibration of Flood-Jet Nozzles*
607	*Pesticide Drift*
640	*Cocklebur*
640	*The Annual Nighshades*
640	*Proso Millet*
642	*Field Bindweed*
642	*Jerusalem Artichoke*
642	*Pigweeds (Redroot, Green and Smooth)*
641	*Long-Term Weed Control Planning*

SOILS

Ontario Soils – Publication 492 – Price $1
Windbreaks on the Farm – Publication 527

Factsheets:

100/516	*Tillage for Crop Production on Ontario Soils – Practices*
100/536	*Tillage Practices for Residue Management and Erosion Control*
100/516	*Tillage for Crop Production on Ontario Soils – Principles*
100/538	*Manure for Crop Production*
100/540	*Foliar and Liquid Fertlizers*
100/531	*Zinc Requirements for Field Crops*
534	*Soil Acidity and Liming*
542	*Guidelines for Safe Rates of Nutrients Applied at Seeding*
554	*Surface Drainage*
555	*Management of Drained Fields*
540	*Chemical and Organic Fertilizers*
100/541	*How and Where to Use Sewage Sludge in Crop Production*
562	*Irrigation – Water Supply*
573	*Grassed Waterways*
573	*Gulley Erosion Control*
606	*Soil Fumigants*

PESTICIDE USE

Factsheets:

607	*Protective Clothing When Using Pesticides Outdoors*
607	*Farm Storage of Pesticides*
607	*Pesticide Contaminatin of Farm Water Supplies*
607	*Pesticide Drift*
607	*Pesticide Container Rinsing*

AVAILABLE FROM ONTARIO MINISTRY OF THE ENVIRONMENT FIELD OFFICES

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs

AVAILABLE FROM INFORMATION SERVICES, AGRICULTURE CANADA, OTTAWA K1A 0C7

Growing and Managing Alfalfa in Canada – Publication 1705E
Reed canarygrass: a production guide – Publication 805E
Production of Field Peas in Canada – Publication 1710E
Growing Flax in Canada – Publication 1577E
Common Insects of Corn in Eastern Canada – Publication 945E
Ergot of Grains and Grasses – Publication 1438E
Insects and Mites in Farm-Stored Grain – Publication 1595E
Control of the European corn borer – Publication 1738E
Smut diseases of wheat, barley, oats and rye – Publication 1766E
Farm pasture fencing – Publication 1568E

AVAILABLE FROM CANADIAN SEED GROWERS ASSOCIATION BOX 8455, OTTAWA, ONTARIO K1G 3T1

Pedigreed Forage Seed Production
Rogues and Roguing Cereal Crops

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetre (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m × 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001L)

Weight Measures

100 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry—Liquid Equivalents

1 cm^3 = 1mL
1 m^3 = 1000 L

METRIC EQUIVALENTS

Length

inch = 2.54 cm - 25.4 mm
foot = 0.30 m
yard = 0.91 m
mile = 1.61 km

Area

square foot = 0.09 m^2
square yard = 0.84 m^2
acre = 0.40 ha

Weight

ounce = 28.35 g
pound = 453.6 g
ton = 0.91 tonne

Pressure

pounds per square inch = 6.90 kPa

Volume (dry)

cubic yard = 0.76 m^3
bushel = 36.37 L

Volume (liquid)

fluid ounce (Imp.) = 28.41 mL
pint = 0.57 L
gallon (Imp.) = 4.55L
gallon (U.S.) = 3.79 L

Temperature

°F = (°C × $^9/_5$) + 32
°C = (°F - 32) × $^5/_9$

APPROXIMATE APPLICATION RATE CONVERSIONS

Metric to Imperial

litres per hectare × 0.09 = gallons per acre
litres per hectare × 0.36 = quarts per acre
litres per hectare × 0.71 = pints per acre
millilitres per hectare × 0.015 = fluid ounces per acre
grams per hectare × 0.015 = ounces per acre
kilograms per hectare × 0.89 = pounds per acre
tonnes per hectare × 0.45 = tons per acre

Imperial to Metric

gallons per acre × 11.23 litres per hectare (L/ha)
quarts per acre × 2.8 litres per hectare (L/ha)
pints per acre × 1.4 litres per hectare (L/ha)
fluid ounces per acre × 70 millilitres per hectare (mL/ha)
tons per acre × 2.24 tonnes per hectare (t/ha)
pounds per acre × 1.12 kilograms per hectare (kg/ha)
ounces per acre × 70 grams per hectare (g/ha)

METRIC APPLICATIONS RATES WITH AN ACRE PERSPECTIVE

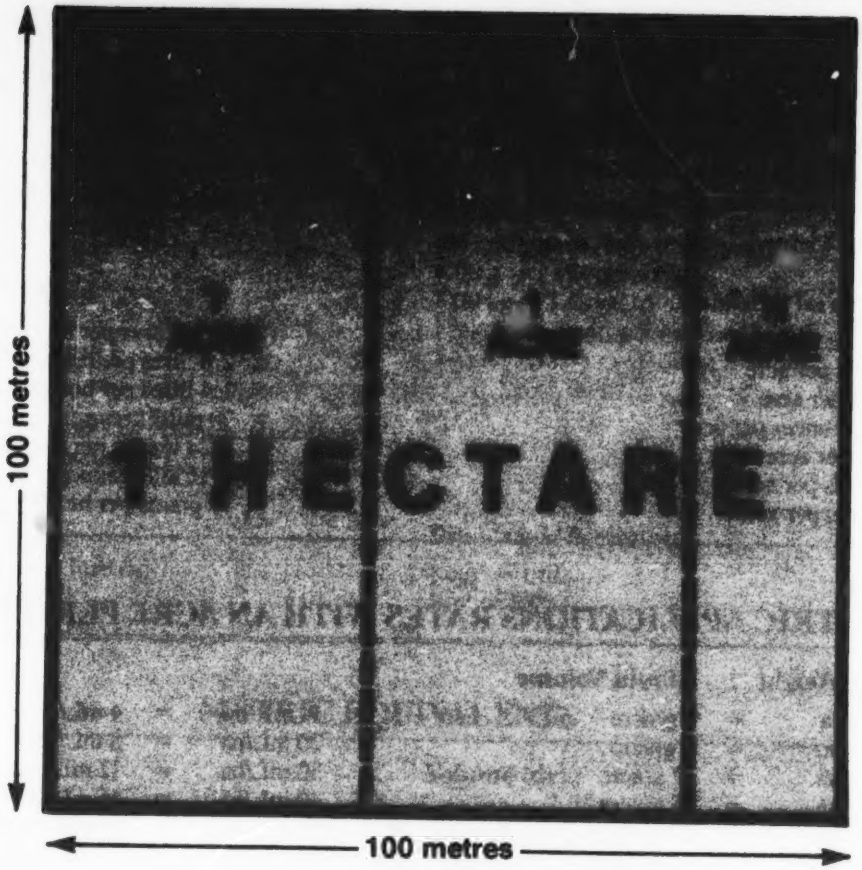
Dry Weight

10 g/ha = 4 g/acre
20 g/ha = 8 g/acre
30 g/ha = 12 g/acre
40 g/ha = 16 g/acre
50 g/ha = 20 g/acre
100 g/ha = 40 g/acre
500 g/ha = 200 g/acre
1000 g/ha = 400 g/acre
1 kg/ha = 400 g/acre (0.4 kg/acre)
2 kg/ha = 800 g/acre (0.8 kg/acre)
3 kg/ha = 1.2 kg/acre
4 kg/ha = 1.6 kg/acre
5 kg/ha = 2 kg/acre
10 kg/ha = 4 kg/acre
20 kg/ha = 8 kg/acre
30 kg/ha = 12 kg/acre
40 kg/ha = 16 kg/acre
50 kg/ha = 20 kg/acre
100 kg/ha = 40 kg/acre
500 kg/ha = 200 kg/acre
1000 kg/ha = 400 kg/acre
1 tonne/ha = 400 kg/acre

Liquid Volume

10 mL/ha = 4 mL/acre
20 mL/ha = 8 mL/acre
30 mL/ha = 12 mL/acre
40 mL/ha = 16 mL/acre
50 mL/ha = 20 mL/acre
100 mL/ha = 40 mL/acre
500 mL/ha = 200 mL/acre
1000 mL/ha = 400 mL/acre
1 L/ha = 400 mL/acre (0.4 L/acre)
2 L/ha = 800 mL/acre (0.8 L/acre)
3 L/ha = 1.2 L/acre
4 L/ha = 1.6 L/acre
5 L/ha = 2 L/acre
10 L/ha = 4 L/acre
20 L/ha = 8 L/acre
30 L/ha = 12 L/acre
40 L/ha = 16 L/acre
50 L/ha = 20 L/acre
100 L/ha = 40 L/acre
500 L/ha = 200 L/acre
1000 L/ha = 400 L/acre

ACRES BECOME HECTARES



100 m x 100 m = 10,000 m^2 = 1 hectare (ha)

HECTARES TO ACRES

1 hectare	=	2.5 acres
2 hectares	=	5.0 acres
3 hectares	=	7.4 acres
4 hectares	=	10.0 acres
5 hectares	=	12.4 acres
6 hectares	=	15.0 acres
7 hectares	=	17.3 acres
8 hectares	=	20.0 acres
9 hectares	=	22.2 acres
10 hectares	=	25.0 acres
20 hectares	=	50.0 acres
30 hectares	=	74.0 acres
40 hectares	=	100.0 acres
50 hectares	=	123.5 acres

ACRES TO HECTARES

1 acre	=	0.4 hectares
2 acres	=	0.8 hectares
3 acres	=	1.2 hectares
4 acres	=	1.6 hectares
5 acres	=	2.0 hectares
6 acres	=	2.4 hectares
7 acres	=	2.8 hectares
8 acres	=	3.2 hectares
9 acres	=	3.6 hectares
10 acres	=	4.0 hectares
20 acres	=	8.0 hectares
30 acres	=	12.0 hectares
40 acres	=	16.0 hectares
50 acres	=	20.0 hectares
60 acres	=	24.0 hectares
70 acres	=	28.0 hectares
80 acres	=	32.0 hectares
90 acres	=	36.0 hectares
100 acres	=	40.0 hectares

NOTES

ERRATA

Publication 296 - "1986 Field Crop Recommendations".

The product **LORSBAN** was listed as having a temporary registration.

LORSBAN has **full registration status** and is registered for use on corn, canola and cereals.

Lorsban should be removed from the list of chemicals on the inside front cover under the write up on "Temporary Registration of Pesticides".

Page 7 **Corn Rootworm Control**

Lorsban 15G has full registration. The asterisk (*) and note at the bottom of the table do not apply.

Growers should use this material in the same manner as they did in 1985.

Issued by the Communications Branch,
Ontario Ministry of Agriculture and Food
29/01/86

1986 FIELD CROP RECOMMENDATIONS

Information supplied under the direction of the Ontario Field Crops Research Committee, composed of representatives of the following organizations:

- Ontario Agricultural College
  - University of Guelph
- Ontario Ministry of Agriculture and Food
  - Colleges of Agriculture Technology:
    - Centralia
    - Kempville
    - New Liskeard
    - Ridgetown
  - Agricultural Representatives Branch
  - Plant Industry Branch
- Agriculture Canada
  - Research Station, Harrow
  - Research Station, Ottawa
  - Research Station, London
  - Research Station, Kapuskasing
  - Research Station, Thunder Bay
- Ontario Cereal Crops Committee
- Ontario Corn Committee
- Ontario Crop Protection Committee
- Ontario Field Bean Committee
- Ontario Forage Crops Committee
- Ontario Oil and Protein Seed Crops Committee
- Ontario Soil Management Research Committee
- Ontario Weed Committee

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- Food Service Supervision

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New Liskeard, Ontario
Telephone: (705) 647-6701

- Agricultural Technology
- Dairy Technology
- Equine Technology
- Livestock Technology

Ridgetown College of Agricultural Technology
Ridgetown, Ontario
N0P 2C0
Telephone: (519) 674-5456

- Agricultural Business and Commerce
- Agricultural Laboratory Technology
- Agricultural Production and Management

University of Guelph
Guelph, Ontario
N1G 2W1
Telephone: (519) 824-4120

- Agribusiness
- Farm Operators and Managers
- Horticulture

Ministry of
Agriculture
& Food

Jack Riddell
Minister
Clay Switzer
Deputy Minister

Ontario

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